Wildlife Refuges

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WILDLIFE REFUGES

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Wildlife Refuges

by

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Director of the Fish and Wildlife Service
United States Department of the Interior

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DEDICATED

TO THOSE PIONEER CONSERVATIONISTS

WHOSE LONG AND VALIANT EFFORTS LAID

THE FOUNDATION ON WHICH THE

NATIONAL WILDLIFE REFUGE SYSTEM

WAS BUILT

INTRODUCTION

This book was originally planned to tell the story of the national wildlife refuge system administered by the United States Fish and Wildlife Service. As the work progressed it became increasingly evident that the history and philosophy of all types of refuges were so completely intermingled that all should be treated as a unit. The plan of work was therefore revised. While the book is still largely the story of the national refuges, enough of the history and status of all types of refuges in North America has been included to give an overall picture of present conditions. The greatly enlarged scope of the work has required the omission of many interesting phases of this fascinating conservation story. However, within space limitations, the details that make the refuge story such a gripping drama for those who have been privileged to have a part in it have been retained.

My thanks are due to those in the Service who reviewed the manuscript, notably W. L. McAtee, H. P. Sheldon, J. Clark Salyer II, Dr. Clarence Cottam and Frank Earnshaw, each of whom offered valuable suggestions and criticisms. Dr. H. L. Shantz has reviewed the part covering the refuges administered by the Forest Service, and V. H. Cahalane and C. C. Presnall have performed the same service for the section dealing with national parks. The governments of Canada and Mexico, the state conservation departments, and the private organizations that maintain refuges have been most generous in furnishing information on which various chapters are based.

The information on the national refuges is naturally from the files of the United States Fish and Wildlife Service or from published material based on them. The story has, however, been written against a background of personal observation, in the course of which every major national refuge, except one, has been visited at least once. It has also been my good fortune to

see most of those in Alaska, most of our national parks and some of both the Canadian and the Mexican parks.

Many state and private refuges have also been visited, although in these cases the number seen has been only a small part of the total.

IRA N. GABRIELSON

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WILDLIFE REFUGES

PLATE 1

LAND FOR WILDLIFE IS A VITAL PART OF ANY PRESERVATION OR RESTORATION PROGRAM

Upper. Without land for their use this herd of bison now on the National Bison range could not exist.

Fish and Wildlife Service photograph by Francis Harper

Lower. Year-round living quarters must be provided if the winged squadrons of waterfowl are to be preserved.

Fish and Wildlife Service photographs by P. J. Van Huizen, Sacramento National Wildlife Refuge

PLATE 2

WATER RESTORATION IS THE KEY TO THE MIGRATORY WATERFOWL REFUGE PROGRAM

Upper. Headquarters at Lower Souris National Wildlife Refuge. The marshes created by this impoundment now produce more than a hundred thousand waterfowl each year.

Fish and Wildlife Service photograph by C. J. Henry

Lower. Malheur Lake, once dry is again becoming one of the biological wonderlands of the continent.

Fish and Wildlife Service photograph by F. W. Ouradnik

CHAPTER I

History of the Refuge Movement

Man is still close to the primitive. Despite living in a mechanized industrial age he still responds to the call of the wild. The strident-voiced geese breasting their course through storm-driven mists, the thundering-hoofed herds of buffalo that cut deep trails through the dusty plains in their mass migrations, the circling cranes, their hoarse gutterals dripping back to earth long after the birds themselves have vanished in the blue, the salmon in mighty leap driven by the spawning urge to return to natal waters, and waterfowl with their myriad wings winnowing out a symphonic music—these and others have, and so far as they still remain, set the blood of man racing and tingling through his veins.

The buffalo are but a memory—a memory kept alive in a number of carefully guarded herds. The waterfowl, along with many others of the wild folk, traveled far down the path to extinction before the onward rush of the white man. Some, forced all the way, are the ghosts of a vanished heritage.

Our grandfathers saw wildlife wonders that we shall never see and we have viewed natural spectacles that perchance none of our children or their children's children will ever see. Some, who can remember the great buffalo herds, are still among us. Many yet live who saw great waterfowl flights, almost if not quite the equal of those that excited the wonder of the early colonists. Many more, who saw the wildlife wither and disappear like autumn leaves before the careless storm of an advancing civilization, can only bemoan the tragedy of the wastage.

Our fathers who pioneered this land accomplished much for which they should be praised but, in their ignorance, they did many things that had been better left undone. In retrospect the waste of soil, of water resources, of forests, and of wildlife seems appalling to a generation that must now dole out these things with miserly hands while working to rebuild them.

Land—the good earth to till and farm—this was the lure

that drew the pioneers onward. To get the land, wildlife was ruthlessly slaughtered; great forest trees were girdled and their dead carcasses cut, piled, and burned to hurry them out of the path of the plow. Later generations continued these practices and themselves went on to draining marshes and lakes and straightening streams in a fantastic scramble for the last acre, good or bad, that might be ripped by the insatiable plows. Even the arid grasslands felt the scourge of the land hunger—to the temporary profit of the speculators and promoters, but often to the financial ruin of those who undertook to make a living from the dusty fields.

Even during the period of wildest exploitation there were those who realized the folly of such wasteful use of these resources, but their voices were little heeded by the hurrying, bustling, white hordes bent on conquering and consuming a continent in record time. However, these protestants made an impression which grew through the years and became the foundation of the conservation movement that began its sweep soon after the turn of the century.

The tale of greed and exploitation has been told many times. The story of its halting in time to save remnants that can be, and in some cases are being, built back as usable resources is still too recent to be completely unfolded. The achievement of the once-small but steadily growing band of valiant spirits, further visioned than their contemporaries, is an inspiring tale that should be repeated over and over again. This writing will touch on their crusade only incidentally in presenting what is a single chapter of American conservation history—the story of the birth and growth of the great national wildlife refuge system, now a major factor in the restoration of our wildlife resources to a point where they are again making important contributions.

As one among those privileged to watch this refuge system evolve, it is gratifying to record its development. Years ago the Biological Survey's studies of the relation of birds and mammals to agriculture attracted increased public support, but the struggling and financially starved refuges received little attention. In 1915 the twelve-year-old refuge system was ill developed, although it included numerous units of value to colonial nesting sea birds. Survey personnel were even then talking and dreaming of projects really adequate to serve the needs of wildlife. Their vision seemed hopeless, almost ludicrous. Some of the refuges were such in name

alone, for the Survey, with insufficient funds and with inadequate public support, could do little to protect them from poachers. Worse than that, the few most desirable ones, such as those at Lower Klamath Lake, California and Malheur Lake, Oregon, were at the mercy of interests powerful enough to destroy them, while those who had striven for an adequate refuge system stood helplessly by. It is a bitter experience to see the ruin of a biological wonderland, to see it become a desert. It brings a mixed feeling of helpless rage and heartsickness, which must be experienced to be understood. Yet those who knew the wonder of Malheur saw it steadily deteriorate. An aquatic paradise became, successively, a shrinking, withering lake, a stinking mud hole, and finally a barren waste. A similar tragic sequence of events occurred in other places, always in the name of progress. But the destruction of Malheur and Lower Klamath, both sacrificed to the greed of man, seemed especially perfidious because they had supposedly been permanently reserved for the benefit of marsh loving wildlife.

Those who saw such famed marshes as Montezuma (New York), Kankakee (Indiana), Horicon (Wisconsin), and the Souris river bottoms (North Dakota) disappear one after the other no doubt experienced the same frustration and regret. Thousands of other waters, not so widely known but no less fascinating to those who knew and loved them, went the same way. Some of them are lost never to return; others were destroyed to no gain but rather to the lasting detriment of each community. To those conservationists who refused to acquiesce and continued to fight what appeared to be a hopeless and losing battle should go the eternal gratitude of all who love the out-of-doors and the living creatures that are a part of it. Their efforts stirred the public understanding and built up the support which alone made possible the restoration of many of the exploited areas. Within my memory the national refuge system has grown from a scant and poorly balanced set of windfalls to the great coordinated system that now extends from Washington to Florida and from Louisiana to the Canadian border. Including areas in Alaska 17,643,915 acres are now in the national wildlife refuges administered by the Fish and Wildlife Service. In addition, there are many wildlife areas maintained by other federal agencies, and by states, counties, cities, private organizations, and individuals. All together they are approaching adequacy.

HISTORY

All successful movements must originate in some mind, but the name of the person who first seriously proposed wildlife refuges in this country is not recorded. If we ever erect a monument to this seer it must be dedicated to one now unknown. Just what the problems were that first evoked the thought are also unknown. We do know, however, where the idea was first translated into action and to California goes the honor of establishing the first state wildlife refuge by legislation. The bill that created America's first official wildlife refuge was introduced into the 1869–1870 meeting of the legislature by Senator Edward Thompkins (Journal of the Senate 1869–1870, 18th Session, p. 421) and became a law March 18, 1870. Quinn's *History of California* states that in 1852 Samuel Merritt of Oakland bought the land which was then a slough and helped form the body of water now known as Lake Merritt. This wildfowl sanctuary, now in the heart of the business section of Oakland, is an outstanding example of attraction of migratory birds under somewhat adverse conditions. Thousands of waterfowl spend the winter here, attracted by the sanctuary, the food, and the resting grounds provided for them.

We have no present means of probing the events that prompted this pioneer conservation effort. It is interesting to note, however, that examination of the naturalist's magazines of that day failed to disclose a line devoted to this or any other refuge. The birth of this historic first refuge was not even noticed beyond the locality in which it occurred and it remained for later generations to appreciate the significance of the event.

Doubtless long prior to this time there were many farms, estates, and other private properties on which the owners prevented shooting or other molestation of the wild things that stirred their interest, but they attracted so little attention that there is no known record of their number or extent.

Within two years of the establishment of the first wildlife refuge Yellowstone Park, the first national park in the world, was created by the Act of Congress of March 1, 1872. With its reservation a new concept of land use came into being, which is expressed in the following statement * about Cornelius Hedges, a member of the Washburn–Langford–Doane exploring party,

* Areas administered by National Park Service Information Tables. Revised as of June 30, 1940 (a processed pamphlet).

the first scientific expedition to investigate the Yellowstone country.

At a campfire conference following the explorations, the site of which is still preserved in Yellowstone Park, this Montana lawyer advanced the idea that the Yellowstone should never be exploited for private benefit, but should be set apart for the use and enjoyment of all the people. A bill of rights for its natural scenery was embodied in the provisions which made mandatory "the preservation from injury or spoilation all mineral deposits, natural curiosities or wonders within said park and their retention in their natural condition," and the protection of fish and game in the park against "wanton destruction" or capture or destruction for the purpose of merchandise or profit.

While the killing of wildlife in the Park was not stopped until many years later (1894), this Act was the first federal legislative expression of an idea that became the foundation for numerous subsequent reservations of lands and resources for public use. Now we have national systems of forest reserves, national parks and monuments, wildlife refuges, and grazing districts, all dedicated to preserving some of the natural resources for the use and enjoyment of the public.

In the early 1870's the newly established sportsmen's journal, *Forest and Stream,* began to demand the preservation of the Adirondacks. This agitation eventually culminated in the establishment there of a great state forest preserve, wildlife area, and public playground.

California established the first refuge in 1870 but the impetus seemed to stop there. So far as present state conservation agencies could furnish historic information it was not until 1903—thirty-three years later—that Indiana became the second state to create a wildlife refuge. Pennsylvania (1905), Alabama (1907), Massachusetts (1908), Idaho (1909), and Louisiana (1911) followed.

These happenings, isolated though they may seem, started a leaven working which was to develop into the conservation crusade which, among many other gains, brought about the reservation of numerous local, state, and national areas for many public purposes. As a result the people have had increasing opportunity to visit these reserves, to use and enjoy them, and to learn their value to the entire community. This process has in turn made it easier to maintain, and where necessary extend, the system of reservations.

The year 1903 saw the first federal wildlife refuge established. At that time Pelican Island, in Indian River, a lagoon on the east coast of Florida, became a federal refuge by Executive Order of President Theodore Roosevelt. This tiny island long ago became an insignificant part of the refuge system. Even the pelicans indicated loss of interest by abandoning it for many years as a breeding place. However, birds may return to such areas as suddenly as they leave and the pelicans did come back to Pelican Island in 1939.

Pelican Island is of major importance as being the symbol of first national recognition of the desirability of wildlife reserves on an equal basis with those for scenic values, forest resources, and historic shrines. One might reasonably say that on this small beginning has been built present federal wildlife conservation policies and programs.

Great things were stirring. The struggling conservation movement was quickening into life for its first lusty stride into American public consciousness. Prodded by a militant body of conservationists, America began to awaken from her long indifference to the destruction of her natural resources. Many types of conservation effort developed new life and new vigor. The national forest system, the agitation for which originated in the early 1870's coincident with the beginning of the national park and wildlife refuge ideas, saw its most rapid period of expansion in the early years of the present century. While the first national forest law was passed in 1891, the actual establishment of many of the western national forests, the backbone of the present system, came in 1905.

A similar expansion of national parks and the development of the national-monument idea started with the reservation of the Mt. Olympus National Monument in 1907.

Led by a crusading band, among whom were Gifford Pinchot, Stephen Mather, E. W. Nelson, William T. Hornaday, T. S. Palmer, John F. Lacy, Frank Bond, George Bird Grinnell, John Burnham, William B. Greeley, John C. Phillips, William L. Finley, T. Gilbert Pearson, F. C. Walcott and others, the conservation movement swept on and began to occupy a definite place in American public thinking.

Between 1913 and 1925 wildlife refuges were established in twenty-four states. Some selected in those more or less experimental years were later abandoned, but the refuge principle

became firmly established as a part of the American system of wildlife management.

During these early years the national park and forest systems grew much more rapidly than did that of wildlife refuges. Increasing state, and later federal, restrictions on the taking of wildlife were relied upon to meet the problems created by a growing army of hunters and fishermen, equipped with better guns and tackle and aided by a rapidly improving transportation system. Even yet constructive programs with appropriate enabling legislation have not been as widely accepted as has been the case with the older conservation movements.

Few, perhaps none, of those involved realized that March 14, 1903, was the natal day of a federal refuge system destined to become the largest maintained by any government. In view of the historical significance of the reservation of Pelican Island, it might be well to quote an extract about it from the 1903 report of the Chief of the Biological Survey. Dr. C. Hart Merriam used a single paragraph to tell the story:

> For several years past the State of Florida has made effective efforts to protect certain plume birds by special statutes and later, in 1901, by the passage of a general law prohibiting the killing of all birds other than game. The committee on bird protection of the American Ornithologists' Union has coöperated in this work and for three years has directed its efforts to the preservation of a breeding colony of brown pelicans on a small island in the Indian River on the east coast near the town of Sebastian. This island is less than four acres in extent and during the breeding season is occupied by some 2000 to 3000 pelicans. It was found, however, notwithstanding the State laws and the presence of a special warden, that protection was inadequate. The Department, therefore, on the request of the American Ornithologists' Union and the Biological Survey presented the matter to the Secretary of the Interior, requesting that if practicable the island be set aside as a reservation. This request was approved and on March 14, 1903, the President of the United States issued an order setting aside Pelican Island as a reservation for the protection of native birds under the charge of the Department of Agriculture. A warden was at once appointed and with the continued coöperation of the American Ornithologists' Union every effort is now being made to preserve the colony.

This is the first notice of wildlife refuges in these annual reports which began in 1886, but the 1905 report mentions three more refuges, two of these to be administered by the

Biological Survey: the Breton Islands Reservation, containing three islands off the coast of Louisiana, which was set aside on October 4, 1904, to protect wintering birds and also the breeding species of gulls, terns, pelicans, and other birds; and Stump Lake Reservation, North Dakota, created March 9, 1905, consisting of four small islands with a total area of 27.39 acres in Stump Lake.

On January 24, 1905 Congress passed an act authorizing the President to set up and designate such areas in the Wichita Forest Reserve as should in his opinion be set aside for the protection of game animals and birds and to be recognized as a breeding place therefor. Under this authority the President, on June 2, 1905, proclaimed a suitable area as a national game refuge and placed it under the jurisdiction of the Forest Service. This later became a part of the national wildlife refuge system when on April 1, 1935, by agreement between the Forest Service and the Biological Survey, it was transferred by the Secretary of Agriculture to the latter organization.

During the next few years additional small reservations for colony-nesting birds were created. The personnel of the Survey took much interest in the welfare of those colonies and for several years made brief reports on the nesting success at each and notes on the behavior of the birds. The number of refuges soon grew so large that the practice, though very desirable, had to be discontinued.

One comment in the annual report for 1907 is interesting, as it bears upon the present-day problem of managing fur animals on some of the waterfowl refuges. It concerns the Breton Islands Reservation and is as follows:

> The islands composing this reservation were visited and somewhat damaged by a severe tropical hurricane which swept the Gulf of Mexico in 1906. Breton Island, six miles in length, was split into three parts, and although normally standing 12 feet above water was flooded throughout its whole extent. Many thousands of pelicans were destroyed by being dashed to the ground by the wind. A beneficial feature of the storm, however, was the extermination of the raccoons and muskrats, which had infested the island and which annually wrought considerable havoc among the nesting birds.

Even in those early days realization was beginning to be forced upon those responsible for refuge administration that creating reservations and leaving them without management does not al-

ways produce the desired results. Later experiences, in fact, have demonstrated that the practice can often do as much harm as good to the species for which protection is sought.

The year beginning July 1, 1908 was a banner one so far as establishment of refuges was concerned. During this year, thirty-six reservations were set aside, the majority being small islands for the protection of nesting colonies of birds. A number functioned only to the extent that coöperation of Audubon societies and other agencies could be obtained to furnish patrol.

This year had its distinctly notable events, for the first refuges under administration of a federal wildlife agency were established in Alaska. Among those designated were Bogoslof, Saint Lazaria, and Tuxedni islands, and the Bering Sea reservation which consists of St. Matthew and Hall islands. All of these are still included in the system.

Of greater significance was the fact that for the first time larger areas were reserved. Largely through the efforts of William L. Finley and a small band of supporters, Lower Klamath, Ore., and Malheur lake, Oregon, were set aside as nesting grounds for migratory waterfowl. This year also saw the first reclamation reservoirs and sumps designated as refuges. Some of these are still valuable; others proved of so little use that they were dropped in later years. The significant thing was not so much the number of new refuges, important as that was, but the extension of refuge protection for the first time to forms of wildlife other than colony-nesting species.

Those in the scientific and administrative fields who are closest to the problem of conserving migratory waterfowl now realize that if the money had been available to develop promptly an adequate and well-patrolled waterfowl refuge system immediately following this auspicious beginning, the later disastrous slump in the numbers of these birds might have been prevented, or at least minimized.

The first federal refuge specifically planned to preserve a big-game animal came in 1909 when 12,800 acres of land were acquired on the Flathead Indian Reservation in Montana for a national bison range. Voting of funds to buy this land and fence it was another landmark, it being the first federal appropriation for such a purpose. The buffalo were to be furnished by the American Bison Society. The fence was completed and thirty-seven bison were released in the new enclosure October 17, 1909.

In the same year the Olympic National Monument was set aside to provide special protection for the Roosevelt elk; this reservation later was expanded into the Olympic National Park, which now furnishes sanctuary to the largest existing herd of these animals.

From 1910 to 1916 the number of refuges increased slowly. The majority were small areas for colonial nesting birds although a few larger units were acquired. Appropriations were slightly larger and a few more wardens were employed to make at least a beginning on the task of patrolling and protecting the more important reservations. In this period the most significant single event was the appropriation by Congress in 1915 of funds for the purchase of lands in Jackson Hole, Wyoming, and of feed for elk herds wintering there.

The passage of the Migratory Bird Treaty Act (July 3, 1918), putting into effect the treaty with Great Britain for the protection of birds migrating between the United States and Canada, made the migratory waterfowl problem a federal one, and while it contained no direct provision for refuges, the stimulation it gave to general conservation activities was undoubtedly of indirect help in this field.

The 1917 report of the Biological Survey draws attention to the increasing difficulties of the waterfowl refuges and the waterfowl population generally.

> At the Malheur and Klamath reservations, Oregon, deplorable conditions exist on account of uncertainty concerning the status of certain lands embraced within these reservations. These conditions are under investigation and it is confidently expected that both these reservations which are of world-wide fame as natural breeding places for birds and which should be unique and valuable assets not only for the immediate locality but also for the nation will be permanently preserved for the public benefit, and not be sacrificed for the temporary advantage of a few interested persons.

A second significant statement is:

> Increased protected areas suitable for breeding places for the migratory wild geese, ducks, cranes, swans, curlew and shore birds should be provided. Additional wildlife refuges along the paths of migration are needed in order to secure improved and equalized opportunities for shooting wild fowl for food and recreation, particularly in Iowa, Missouri, Kansas and Illinois.

The 1920 report, in discussing conditions at Klamath Lake reservation, states:

> The water table on the lake has been lowered several feet by closing the gates which control the inflow from the Klamath River. This action, made under agreement with the water users' association, has uncovered large areas of alkali flats without thus far benefitting the settlers adjoining the lake or opening up additional land suitable for agriculture. A soil survey made during the summer of 1919 has shown that the lands thus uncovered have little, if any, agricultural value. The act authorizing the elimination of certain agricultural lands from the reservation recently approved should result in determining the permanent boundaries of the reservation. If an agreement can be made for raising the water level slightly, Klamath Lake can still be made one of the most important bird reservations in the West; otherwise its future as a refuge is seriously jeopardized.

This is surely an understatement of the wildlife tragedy involved in the loss of one of the two greatest waterfowl refuges then in existence.

The same report again indicates that years before an effective mechanism for developing a refuge system came into being, those who were responsible for the welfare of the migratory waterfowl were alive to the significance of the drainage of lakes and marshes. We read:

> For two years the Biological Survey has made a special effort to draw the attention of all sportsmen, including state game commissions, to the menace to the future of our migratory wild fowl through the drainage of small lakes and swampy areas on a constantly increasing scale. The appreciation of the situation is becoming general and it is hoped that effective steps may be possible whereby the federal and state governments may secure permanent title to a number of such areas to be maintained in perpetuity as bird preserves.

and further:

> Other important uses for lake and marsh areas in many places are the maintenance of the normal underground water level, affecting springs, wells and vegetation, often at considerable distances, and the prevention of erosion by delaying the run-off of flood water.

In 1921 more water than usual flowed into Lake Malheur but attention, nevertheless, was called to the fact that extensive irrigation projects diverting water from the lake threatened its

very existence. The only comment concerning Lower Klamath Lake, also one of the most prized refuges, was that exclusion of water had greatly decreased the importance of the lake as a wildlife breeding place. These statements and others in various publications, by members of the Biological Survey and by many other conservationists, accurately forecast the eventual destruction of both these famed waterfowl resorts.

Between 1916 and 1920 contingencies of the World War injured waterfowl, among them being the plowing of the plains in the drive to produce more food—a move that destroyed many of the remaining breeding grounds. The war also affected all conservation work by directing public attention elsewhere. Appropriations were cut and exploiters generally had their way.

June 1924 was an important landmark in the history of refuge legislation. Congress enacted a bill authorizing the appropriation of $1,500,000 for the purchase of bottomlands along the Upper Mississippi River to establish a refuge for birds, other wildlife, and fish. This was the first time that Congress definitely appropriated money for purchasing a general wildlife reservation. The terms of the act, limiting acquisition to overflow lands and setting a maximum price of $5 per acre (later raised to $10), made a long drawn-out purchase program inevitable. Hundreds of tracts were involved but the area has finally been almost entirely purchased.

The report for 1924 again emphasized the increasing menace of drainage programs to the future of the migratory waterfowl and devoted considerable attention to this problem. Despite such warnings from the nation's official wildlife agency and a rising chorus of protests from conservation organizations, it was not until many years later that adverse public opinion became powerful enough to have any noticeable effect upon the activities of drainage enthusiasts.

The annual report for 1927, reflecting the growing public interest in refuges, for the first time presented a comprehensive outline of the need for adequate breeding, feeding, and resting grounds for the migratory waterfowl to fulfill treaty obligations with Canada, and mentioned the fact that a measure providing for such refuges had failed of enactment through several sessions of Congress because interested individuals and conservation groups had failed to agree on its provisions.

A second special wildlife refuge act, however, became law

on April 3, 1928. It authorized an appropriation of $350,000 for the establishment of the Bear River Migratory Bird Refuge on the marshes at the mouth of Bear River, Utah. Of this sum $200,000 was made immediately available. This law provided that when the refuge was completed, not less than 60 per cent of the area was to be maintained as an inviolate sanctuary, the remainder being subject to possible use as a public shooting ground. Engineering studies were made, plans developed, and construction started without undue delay. This was the first development of a marsh by the federal government for wildlife conservation. It now seems almost providential that some experience in marsh restoration was gained prior to the great rush of construction and development that started in 1934.

In 1928, 1760 acres of land were added to the elk refuge as a gift from the Izaak Walton League, completing the program arranged some time before.

On February 18, 1929, the long battle for legal authority to purchase and establish a system of migratory bird refuges was ended by passage of the Norbeck-Andresen Migratory Bird Conservation Act. This legislation, the latest of a series of introduced bills to develop waterfowl programs, authorized appropriations in increasing amounts from year to year and outlined specific provisions for the development of a system of refuges. It also established the Migratory Bird Conservation Commission, composed of the Secretaries of Agriculture, Commerce, and Interior and two members each of the Senate and the House.

Under the impetus of these three new laws (the Upper Mississippi River Refuge Act, the Bear River Marsh Act, and the Norbeck-Andresen Act), and a rapidly growing public sentiment, the program of refuge expansion and development made good progress. Preliminary work was started on the Bear River refuge, engineering work and land acquisition on the Upper Mississippi were expedited, and steps were taken to establish a bird refuge at Cedar Keys, Florida, and an antelope refuge in Nevada in cooperation with the National Audubon Society * and the Boone and Crockett Club.

The following year (1930) witnessed completion of a food-resources survey and determination of the biological fitness of areas recommended for migratory bird refuges, including 189

* The name of this organization was changed in 1940 from National Association of Audubon Societies.

units in 48 states aggregating more than 3,700,000 acres, and land-valuation surveys of 40 of these in 20 states, involving approximately 1,225,000 acres.

The new Migratory Bird Conservation Commission authorized the first two purchases and approved the withdrawal of two additional areas of public domain as recommended by the Biological Survey.

Congress also passed a special bill authorizing $250,000 for the acquisition of the necessary areas of land and water for the establishment of the Cheyenne Bottoms Migratory Bird Refuge in Kansas, a refuge project that has yet to be consummated although the possibilities are still there. An oil boom, which developed at the time land purchase was undertaken, sky-rocketed prices to the extent that it was impossible to obtain land on reasonable terms. Favorably located in relation to the flyway, this unit is needed to complete the chain of refuges through the central plains.

During the same year (1930) contracts were let for the construction of dikes on the Bear River refuge and the drag lines began for the first time the work of creating an artificial marsh to replace environment destroyed thruout the land in the heyday of drainage-promotion schemes.

Additional acreage for refuges was also withdrawn from the public domain. The Salt Plains area in Oklahoma, whose 20,000 acres of arid salt flats could be flooded by diversion of certain waters, was the most important. Proposals for flood-control work, together with other uncertain factors, delayed this development, but the area has now been reflooded and has proved to be a valuable link in the waterfowl refuge system.

During 1931 the acquisition of four new refuges was approved by the Migratory Bird Conservation Commission. These were: St. Marks Refuge in Florida; Salton Sea Refuge in California; Swanquarter Refuge in North Carolina; and the Crescent Lake Refuge in Nebraska. Three of the four have expanded into major units, but the Salton Sea lands have not yet been developed due to the flooding by salt water, inability of the federal wildlife bureau to acquire all of the needed lands and the engineering problems to be solved.

In addition, 30,700 acres of public land in northern Nevada, adjoining the private lands being purchased by the National Audubon Society and the Boone and Crockett Club, were with-

drawn and together established as the Charles Sheldon Antelope Refuge.

During 1931 the Biological Survey also obtained the first emergency funds which, for the next several years, were to play such an important part in the conservation program. These funds made it possible to survey and properly mark the boundaries of many new refuges, to provide badly needed equipment, and to start important development work.

By August 31 of that year construction at Bear River was near enough completion to permit the flooding of the newly enclosed areas. Thus the first reflooding of lands for the primary use of migratory birds became an accomplished fact; it was no longer a dream. From the tiny Pelican Island of 1903 the refuge program had made great progress indeed. The spreading waters slowly covering the baked alkali flats along Bear River were eloquent indications of the fact. Conservation sentiment itself had become a rising tide in the eighteen intervening years, and was destined to go much higher than this stage, which before had seemed unattainable.

In 1932 numerous refuges were added to the system by direct purchase, by withdrawal of public lands, and one by gift—the last being Chinsegut Hill, Florida, the gift of Raymond Robbins. Despite this progress, however, prospects seemed black. The depression was at its worst and supporting funds decreased so drastically in this and succeeding years that the movement so promisingly begun in 1928–1930 seemed destined to die from financial anemia, a fate that had overtaken many other meritorious movements.

In early 1933 the Civilian Conservation Corps came into being. At first the event did not seem of great interest to wildlife conservationists, but it was another of those happenings which none consider epochal at the time but which later have brought about startling results.

On May 29, 1933, the President approved the establishment of the first of three Civilian Conservation Corps camps on wildlife refuges—one at the Blackwater Migratory Bird Refuge in Maryland, the second at Swanquarter Refuge in North Carolina, and the third at St. Marks Refuge, Florida. It was unfortunate that land acquisition had not proceeded far enough to justify a much more extensive assignment of these camps to refuges, for other agencies with land already available had first call and it was only

by constant effort that the total of camps on refuges reached the peak of thirty-eight before national defense lessened their numbers. The war finally closed all camps. Had land been available to provide work for from 100 to 150 camps the minimum development objective might have been accomplished in the next six years.

A Presidential committee on wildlife restoration, consisting of Thomas Beck, Jay N. Darling, and Aldo Leopold, was appointed in January 1934. It made two major contributions to the refuge program. First, it set a higher goal for wildlife restoration when it recommended the allocation of $50,000,000 for the purchase and restoration of submarginal and other lands for game, nongame, fur, and other wildlife species. At the same time it called attention to the desperate plight of the migratory waterfowl due to a combination of overshooting, overdrainage, and the cumulative effect of intense droughts. As has happened so often, America required desperate conditions to produce adequate action. Thus, the very factors that seemed to be driving wildlife inexorably to its doom supplied the impetus necessary to reverse the current and start the wildlife population slowly upward. The committee's second major contribution was dynamic "Ding" Darling, who stepped from his committee job to become Chief of the Biological Survey. His ability to dramatize in a few words the plight of the wild creatures furnished the slogans with which the growing conservation army went to battle. One community after another espoused the cause of the "bowlegged girl" (wildlife conservation) whom nobody ever invited to the picnic. Darling's "straw" with which he "sucked funds for wildlife out of the other fellow's barrel" and his passionate pleas for wildlife lands on the theory that "ducks can't lay eggs on a picket fence" became bywords that roused the conservation forces to a new high in united and sustained effort.

His term of Chief of the Survey was short but he made a major contribution to American conservation. With his enthusiasm and magnetic, driving personality he forced the restoration of wildlife lands and the development of the federal refuge system ahead at an accelerated pace that carried the program far toward completion. Entry of the country into the second World War has now resulted in a slowing down of the effort which, however, must be only for the duration if the wildlife resources of the country are to be permanently secured.

PLATE 3

BADLY ERODED LANDS ARE USELESS TO MAN

Often they can be started on the road to recovery by plantings for wildlife. Many such areas have become parts of the refuge system.

Upper. Such badly eroded lands as this are useless for any purpose.

Fish and Wildlife Service photograph by F. W. Ouradnik

Lower. Transplanted vegetation helps stop erosion and eventually provides food and cover for wildlife.

Fish and Wildlife Service photograph by Howard A. Miller

PLATE 4

SUITABLE PLANTINGS GREATLY ENHANCE THE VALUE OF MANY NEW REFUGES

Upper. Clump plantings will greatly increase the food and shelter in Arrowwood National Wildlife Refuge.

Fish and Wildlife Service photograph by E. W. Craven

Lower. Large trees can sometimes be moved in to provide shelter and food immediately. Valentine National Wildlife Refuge.

Fish and Wildlife Service photograph by Ward M. Sharp

More than any other single individual he dinned the plight of America's wild things into the consciousness of a vast part of the public that had been indifferent. In a short time and from various sources $8,500,000 of emergency funds was obtained for the purpose of buying lands, and constructing fences, dikes, dams, and necessary buildings. A special fund of $1,000,000 was set aside by the President for the purchase of migratory waterfowl refuges; $1,500,000 was allocated for the same purpose from the submarginal land retirement fund, and $3,500,000 from drought-relief funds to be used for the purchase and development of lands within the drought-stricken areas. From Works Progress Administration funds, $2,500,000 was allotted for engineering operations to restore and control water levels, to check erosion, and to improve food and other environmental conditions on federal wildlife refuges.

This golden flood, bringing new life into the previously starved refuge program, was further augmented by the Migratory Bird Hunting Stamp Act of March 16, 1934, receipts under which provided a fund for purchasing and developing land. The act, which requires every duck and goose hunter over sixteen years of age to purchase a Federal Migratory Waterfowl Hunting Stamp, has provided annual funds varying from $448,204 to $1,260,810. Ninety per cent of the money must be used for migratory waterfowl refuges, the remaining 10 per cent being available for the administration of the act.

With the advent of "Ding" and the provision of funds on a scale much greater than previously dreamed of, activity in the Biological Survey became hectic. Few trained men were available for the new positions needed and it was impossible to employ and train them fast enough to meet the demand. The few that could be found plus available personnel in the Survey attempted to do the job by working longer hours at a feverish pace. "Ding" himself led the way, always doing more than he asked of others. Those who were in the team are still too close to this sudden acceleration of a program that had grown all too slowly over the years, truly to appraise the accomplishments of those busy months. Reports as to what was accomplished are confusing because some were issued on the basis of lands optioned, some on the basis of lands to which title had passed to the government, and still others on the basis of the acreages included in approved projects. Great projects were initiated, surveys and actual negotiations for lands

carried forward at a dizzy pace, and buildings, dikes, and dams rushed to the construction stage with the dual objective of employing relief labor in rural communities and getting work under way on a scale somewhat commensurate with the needs of wildlife restoration.

A glance at the accompanying tabular account of the refuge program will give an idea of the growth of the system in 1934 and 1935 as well as subsequent years. During the first of these active years, thirty-two refuges were in actual process of restoration and 653,000 acres of land were optioned in time for letting construction contracts of $892,181 before the deadline set for obligation of funds (from July 1, 1934 to March 31, 1935). When it is realized that before a start could be made it had been necessary to employ land negotiators, surveyors, engineers, draftsmen, reconnaissance biologists, and other types of skilled help, this accomplishment seems little short of miraculous.

Among the contracts were those for heavy construction work on such outstanding refuges as Chautauqua Bottoms in Illinois; Seney in Michigan; Squaw Creek in Missouri; Medicine Lake in Montana; Arrowwood, Des Lacs, Upper and Lower Souris in North Dakota; and LaCreek and Sand Lake in South Dakota. Additions were also made to a number of existing reservations and a very extensive development program was launched on both old and new refuges.

By June 30, 1935, there were twenty-two Civilian Conservation Corps camps on refuges for which acquisition had proceeded far enough to warrant development of the types possible with this aid.

Among the accomplishments of this period were: acquisition of a great part of the White River Refuge in Arkansas, which is one of the outstanding waterfowl concentration areas of the country; the taking of an option on the first unit of the Sacramento Refuge in California; establishment of the Delta, Lacassine, and Sabine refuges in Louisiana, although at the latter it took several years to straighten out all legal tangles and actually acquire title to this superlative refuge; Mud and Rice lakes in Minnesota; Swan Lake in Missouri; Medicine and Red Rock lakes in Montana; Valentine Lakes in Nebraska; Mattamuskeet in North Carolina; the Des Lacs, Lostwood, Lower and Upper Souris in North Dakota; the great P Ranch as an adjunct to Lake Malheur Refuge, a tract that is a great nesting ground and in

addition controls the water vital to the restoration and maintenance of Malheur Lake; the LaCreek and Waubay refuges in South Dakota; Muleshoe Lake in Texas; and the Turnbull area in Washington. Acquisition was not completed on all of these areas, but options were obtained on the major portions of key tracts in all of them and in some cases most of the refuge area as it exists today. A magnificent job was done in getting under way quickly a program far beyond anything that had ever before been possible.

Coincident with this enlarged waterfowl refuge program, additional lands were purchased for the Jackson Hole Elk Refuge, Sullys Hill and Niobrara Game Preserves and the Charles Sheldon Antelope Refuge.

In 1936 Congress made available a direct appropriation of $6,000,000 for the migratory waterfowl restoration program, and for this, too, credit should go to "Ding" and to a group of ardent conservationists in Congress. Between July 1, 1935 and June 30, 1936, options were taken on 811,785 acres of refuge land and title to 227,900 acres was actually transferred to the government. Among other outstanding developments during this year was the establishment of the Hart Mountain Antelope Range in Oregon and the Desert Game Range for mountain sheep in southern Nevada.

At the height of all this effort "Ding," because of ill health, left the Survey after a short but exceedingly productive stewardship. No man ever contributed more to the conservation movement in so short a time.

The Mexican Migratory Bird Treaty, which extended to the migrants between the United States and Mexico the same protection accorded by the Migratory Bird Treaty Act of 1918 to those migrating between this country and Canada, became effective early in 1937. It extends federal protection to a number of species of birds hitherto unprotected by the federal government and, what is more important, provides a base for development of effective conservation in Mexico.

The refuge program continued at an accelerated pace and at the end of the year acquisition was actively under way on sixty-two different refuges, old and new. At the same time restoration of wildlife habitat was started on these lands as fast as title passed to the United States government.

There were also completed during the year a number of

small water-restoration projects under perpetual easements, especially in northern Plains states. Land owners, interested in water restoration, gladly coöperated. Some of these projects have developed into refuge units of such outstanding value as to justify purchase and further development. Others, because of small size or other limiting factors, will be maintained as easement refuges.

The increased quantity of CCC, WPA and other labor contributed another substantial boost to the development program, but few or no funds from these sources were available for the purchase of the required supplies. Fortunately duck-stamp funds became available and, by purchasing fencing material, water-control gates, steel and cement and other necessary supplies with these funds, the development program moved forward much faster than had previously been possible. In this way the effectiveness of the first receipts of duck-stamp funds was multiplied many times.

During the succeeding years progress has been slower, although some lands were purchased with remaining funds, and sufficient emergency relief labor was available until 1941 to do a great deal of development. The accompanying tabulation shows the progress made through these years.

A total of 332,438 acres in seven units, originally acquired by the Resettlement Administration and its successor in submarginal land purchase, the Farm Security Administration, was added to the refuge system in 1939. Five of the refuges—Carolina Sandhills in South Carolina, Little Pend Oreille in Washington, Piedmont in Georgia, Moosehorn addition in Maine, and Kentucky Woodlands in Kentucky—are primarily suitable for general wildlife and upland game, while Necedah in Wisconsin, and an addition to St. Marks in Florida, containing 62,500 acres, are for migratory waterfowl.

By 1939 all appropriated and emergency funds for the purchase of lands were obligated and migratory waterfowl-stamp receipts are now the only funds available for land purchase. Under this limitation a definite policy has been followed of adding necessary lands to existing acquisition projects, and of purchasing key tracts in areas where new refuges are needed. A number of new acquisition units also have been established. There are about fifteen units of major and thirty-five of secondary importance that are still needed to attain the minimum goal for the waterfowl-refuge program.

June 30	Alaska	Continental United States	Total
1903	...	3	3
1904	...	3	3
1905	...	985	985
1906	...	1,304	1,304
1907	...	1,304	1,304
1908	..	21,504	21,504
1909	50,519	383,774	434,293
1910	50,519	383,774	434,293
1911	50,519	383,774	459,593
1912	50,519	383,774	459,593
1913	2,954,262	427,106	3,381,368
1914	2,954,262	427,406	3,381,671
1915	2,954,262	429,735	3,383,997
1916	2,954,262	435,355	3,389,617
1917	2,954,262	440,742	3,395,004
1918	2,954,262	440,742	3,395,004
1919	2,954,262	440,742	3,395,004
1920	2,954,262	441,251	3,395,513
1921	2,954,262	446,206	3,400,468
1922	2,954,262	446,866	3,401,128
1923	2,954,262	446,906	3,401,168
1924	2,954,262	451,565	3,405,827
1925	2,954,262	451,565	3,405,827
1926	2,954,262	466,577	3,420,839
1927	2,967,482	576,957	3,444,439
1928	2,967,482	539,065	3,506,547
1929	4,078,482	678,943	4,757,425
1930	4,078,483	744,294	4,822,777
1931	4,078,482	835,863	4,914,345
1932	4,087,402	915,141	5,002,543
1933	4,087,402	1,625,619	5,713,021
1934	4,087,402	1,762,804	5,850,206
1935	4,087,407	2,012,613	6,100,020
1936	4,087,408	5,656,615	9,944,023
1937	4,287,408	7,144,966	11,432,374
1938	4,294,208	7,356,150	11,650,358
1939	4,294,208	9,235,952	13,530,160
1940	4,294,202	9,341,163	13,635,365
1941	4,294,202	9,446,102	13,740,304
To Dec. 31, 1941	8,026,202	9,617,713	17,643,915

The number of acreage of the various types of refuges, on March 15, 1942, are shown in the following tabulation:

Classification	Number	Acres
Migratory waterfowl	184	2,962,025
General wildlife	25	3,973,754
For colonial non-game birds	46	104,149
For big game	16	10,601,364
For wildlife research	1	2,623
Total	272	17,643,915

CHAPTER II

Purposes, Values and Limitations of Refuges

An early concept of a wildlife refuge was that of a sanctuary for the preservation of individuals of one or more species. Some reservations were, and still are, dedicated to the conservation of one species, while others are intended for all forms. The types of land and water or combinations of these fundamentals; climatic conditions; extent, density, type and variability of cover; availability of food; and efficiency of the protection furnished are among the factors that determine the value of the refuge as well as the species that will be benefited by it.

As noted, it seems safe to recognize as the original concept of a refuge an area of land, or water, or both, set aside and dedicated to the use of wildlife. Such allotment by itself has been often considered all that was necessary for the protection and restoration of wildlife populations. Under that theory, the first quarter of the present century saw a superficial refuge movement sweep the country. It resulted in an impressive number of sanctuaries and total acreage of reserved lands, which too frequently remained mere "paper refuges." Some, owing to unsound choice of location, proved useless, while others failed for lack of management to restore or preserve suitable habitat. Some of the unsuccessful ones and others found to be unnecessary have been abandoned in recent years but there are still many in the nominal refuge class.

During this period of enthusiasm the establishment of refuges of impressive acreages became to some degree an end in itself. Some believed that refuges were the great panacea, the ultimate and final answer to all wildlife problems. Once created, and left alone, an area was supposed to develop automatically into a wildlife paradise. Some still hold this belief, but experience and observation have proved so conclusively that "sanctuaries" are not the sole passport to a wildlife heaven that this philosophy no longer dominates conservation thinking to the extent that it did in the early days.

Despite disillusioning experiences, the sanctuary ideal is still strong, and plays, as it rightly should, a part in the restoration program. Freedom from human interference is still a major wildlife need and one that will become more acute as populations grow and further changes in land use occur. The discovery that provision of "sanctuary" was not a cure-all for the evils affecting wildlife has been disheartening to some. However, it must be pointed out that despite certain shortcomings, sanctuaries and refuges have been a factor in every wildlife restoration effort that has met with substantial success.

MANAGEMENT

Gradually the idea of using land management to insure the best wildlife production has grown. As a part of the scheme, the plan of employing refuges, not as ends in themselves but as tools in the management of game species, has been advanced. Despite the changes this has wrought in the original sanctuary concept, to some extent resented by those who hold to the older idea, it is apparent that both plans have made distinct contributions.

Now, in addition to dedicating to wildlife use lands which under no circumstances are to be altered, we find both management of refuges and the use of sanctuaries as tools in general game management to be of value.

Some, in fact most, refuges serve as production units, the overflow from which tends to restock game on adjoining lands open to hunting. This tendency is inherent in all refuges although the effect varies greatly with the species present. Wide-ranging animals, as deer and ring-necked pheasants, may disperse more readily and farther than such comparatively sedentary forms as rabbits and quail.

Until recently this contribution to the crop of game has been largely incidental. Now, deliberate efforts are made to set up refuges that will act as automatic production and dispersion units. Such areas are sometimes maintained for the purpose of trapping surpluses and transplating them to localities where needed.

A still further refinement in small-game management is the installation at frequent intervals of shelter refuges, intensively developed to suit them to the needs of the species concerned. These small sanctuaries serve the double purpose of preserving

part of the stock through the hunting season and of providing safety islands where both food and cover are available in emergencies. Enough trials have been made of this plan to show that it is a sound new use of the refuge principle.

LIMITATIONS ON THE VALUE OF REFUGES

While a refuge, unprotected and unpatrolled, may be respected by the better class of the population, it is likely to become the semi-private hunting preserve of the lawless element that exists in every community. Such refuges, while they may build up wildlife populations to some extent, are detrimental to a sound wildlife program. Their unsatisfactory condition is often pointed out by interests opposed to wildlife conservation, and the fact that they are closed to law-abiding citizens but in actual practice open to unprincipled marauders is bound to arouse resentment among those who respect their boundaries. Protection should be provided or the refuges abolished.

Definite limitations on the value of refuges exist even where adequate administration and patrol is maintained. The major limitations may be considered as: (1) competition between species; (2) location or size of tract preventing success; and (3) overcrowding it, tending to destroy the food on which the wildlife depends.

The bad effects of competition may be seen on some of the island refuges and breeding rocks of the northeastern coast. Here general protection, provided by both state and federal laws, has given the wildlife populations opportunity to regain or even exceed their original numbers. The ample food supply furnished by the refuse from the great cities favors undue increase of scavenger gulls. Because those birds feed freely upon the eggs of other species, guardians of the colonies sometimes must choose between regulating the numbers of herring and great black-backed gulls and losing the eider ducks, terns and other species.

Another illustration of destructive competition is known on several federal refuges along the south Atlantic and Gulf coasts. Here protection has aided the breeding colonies of terns, skimmers, and gulls as well as the more scattered nesting populations of willets and oyster-catchers. But the same protection also has built the population of raccoons to the point where they threaten the welfare of some of the birds, and it has become necessary to reduce their numbers.

Refuges that may be satisfactory with certain population levels sometimes attract such increased numbers that their value is greatly impaired, if not totally destroyed. Horseshoe Lake, a state refuge in southern Illinois, has been a striking example. Because of its attractiveness to Canada geese, small size, lack of food, and peculiar relation to surrounding lands, it had become a slaughter pen rather than a refuge. During the past two years aggressive efforts to increase the food supply, and the enforcement of more stringent regulations by the state and federal governments have alleviated the difficulty, but it is still a major one. The low standard of sportsmanship of some of those living in the vicinity, as well as of a portion of those who come from a distance to hunt, is an added factor in this particular problem.

Other migratory waterfowl refuges have shown similar shortcomings, although conditions have not become so critical. In most instances it has been possibe to correct the trouble by enlarging the refuge area, developing greater food supplies, and adopting special regulations, or by a combination of these methods. However, the necessity for such correctives emphasizes the fact that there are very definite limitations on refuges. Not every tract of land can be made into a real and serviceable refuge.

Overpopulation has up to this time been most apparent on big game areas, some of them refuges. Elk and deer have been the animals most commonly involved. With protection, and favorable food and climatic conditions, such herbivores have frequently become so numerous that they literally ate themselves "out of house and home." The mass starvation of mule deer on the Kaibab National Forest game preserve in northern Arizona is the classic example, and there are a number of later instances. On the Kaibab not only did the deer herd, under protection, increase beyond the carrying capacity of the immediately available forage but the hungry horde progressively destroyed one favored food plant after another. Although thousands of deer died, the depletion was so great that years were required for the Kaibab to regain enough forage to carry even a modest herd. Such instances show that when the best interests of the wildlife itself are considered a refuge may become a mockery.

VALUE OF REFUGES

Despite the new use concepts outlined and the limitations mentioned, a major value of refuges is still the protection of

wildlife. Refuges are valuable not only in safeguarding individual animals, or groups of animals, but are equally important for the preservation of habitat in which the various species may continue to exist under favorable conditions. Preservation of suitable habitat, or its restoration, will become increasingly important as long as human populations and human use of land continue to increase.

In that respect refuges are the most important wildlife aid we have today and it is imperative that sufficient areas, adequately distributed, be reserved or restored while it is possible. So as far as one may conclude from present knowledge, reserving land for wildlife use is the supremely important conservation function of refuges—no matter what other values they may have. Under varying conditions the refuge may be most important in protecting a species from critical danger, in restoring animals to areas from which they have been extirpated, or in enabling a reduced population of wildlife to restore itself to normal abundance. Game-conservation officials are showing an increasing tendency to use temporary refuges or closed areas to offset the effects of overshooting, or other local unfavorable influences. They have been applied with success in restoring fish populations. This legitimate, if somewhat novel, use of refuges is growing and may well become a factor in maintaining or restoring supplies of game and fish in the face of increased harvesting pressure.

Another conservation contribution of refuges results from the fact that any refuge, properly protected and maintained, will incidentally benefit every form of wildlife that can live upon it. It not only helps resident forms but also protects migratory creatures for the duration of their stay. Many of the federal migratory waterfowl refuges furnish striking examples of such multiple utility. The lands about refuge marshes and lakes often swarm with upland birds and mammals and the marshes and waters, restored for the primary use of ducks and geese, also provide homes for a great variety of other aquatic birds and mammals and are often exceptionally favorable for fish production. While this incidental value for other forms develops automatically to a certain extent, it is often possible, by careful management, to increase it. Because of the limited acreage available managers of areas set aside for wildlife should use their ingenuity to obtain as many varied values as possible from the areas under their administration.

Refuges also contribute to the welfare of wildlife by the moderating effect they exert on the kill of game. Many individuals of game species remain on refuges during the hunting season and others travel in and out of the area, returning when the hunting pressure becomes too severe. Stories that ducks and geese know refuge boundaries by the types of fencing about them are legion, and wherever the hours of shooting are set by law or regulation men will testify that the game, be it duck, geese, deer, or pheasant, "carries a wrist watch" and remains within the refuge until the hour when shooting is over for the day. Thus, refuges help with the first fundamental of any game production program —the preservation of adequate breeding stocks.

Migratory waterfowl refuges add a curious, but on consideration a logical, variant to wildlife service. While preserving birds from the guns, they at the same time, by providing protection, food, and suitable resting places, hold the birds in the immediate locality longer than would otherwise be the case. This is especially noteworthy along the flight lines between breeding and wintering areas. Where protection and ample food and shelter are present, the birds have a strong tendency to remain, even until severe weather drives them onward. Under such conditions a refuge may be in the anomalous position of protecting the birds from too great hunting pressure and at the same time lengthening the period in which local gunners have game available for hunting.

VALUES TO COMMUNITIES IN WHICH REFUGES ARE LOCATED

In addition to their direct contributions to conservation, refuges may have incidental values to the communities in which they are located. The retention of migratory birds in the vicinity of a refuge, when without this attention they would have speedily departed, was originally given little thought, but it is now increasingly appreciated by local gunners. This effect may not immediately follow the establishment of refuges, for several years may elapse before the birds become numerous enough for it to become noticeable. However, it is well enough known to have become a factor in creating pressure for the location of refuges in communities where marsh and water are not naturally available.

Refuges are often of value in easing local flood-control problems and even more frequently in checking soil erosion. They

help by providing water storage, as on the Souris River in North Dakota, where the dams and dikes built to restore and develop breeding marshes also can hold the entire probable run-off of this drainage basin. In only three of all the years for which run-off records have been kept would the storage have been inadequate to handle the flood waters and even in these exceptional years the refuge facilities would have so greatly reduced the run-off as to prevent much of the damage that occurred.

Many refuges also contribute to both flood and erosion control through the vegetation of their lands. Because of lower land values, they are usually in the rougher uplands or lowlands that are submarginal in human economy. They are often started on the most abused and often badly denuded soils. Freed from cultivation and grazing, and often improved by planting, ground cover multiplies and contributes directly to erosion control.

Refuges also contribute to the restoration and maintenance of ground water levels. This may be of vital importance in semi-arid areas, and cases are known where the storage of water on a migratory waterfowl project has been followed by the restoration of small ponds in the vicinity and by the replenishment of wells that had been dry.

Many migratory waterfowl refuges make definite contributions by bringing opportunities for boating, swimming, and fishing into communities that have long been denied, or that may never have had such recreations. In the plains and intermountain country these facilities are highly appreciated by local residents. It is fortunate that it is usually possible to allow such privileges on some part of a refuge without interfering with wildlife uses. At the Chautauqua Refuge, in the Illinois River bottoms, impoundment has resulted in favorable fishing conditions. In 1940, 9034 persons availed themselves of the angling opportunities afforded here, and during a four and one-half months' season took 126,471 fishes. In the Okefenokee Refuge in Georgia, during the same year, 3494 persons took 33,367 fishes.

Many refuges, as they develop, are making increasing amounts of wood, hay, and grazing privileges available to local residents at moderate costs. While refuges are, and should be, primarily for wildlife, it is often possible to furnish to communities services that are not only harmless, but even beneficial, to the wildlife. Under some ecological conditions seasonal grazing of the proper intensity has been found to be a valuable tool in producing more

favorable conditions for certain kinds of wildlife. Likewise refuges inhabited by geese, prairie chickens, and sharp-tailed grouse have been made more useful to these birds by skillfully timed cutting of the native hay crop.

On numerous occasions alert refuge managers have reduced fire hazards from storm-damaged timber, or procured the removal of small timber from areas to be flooded by making the wood available to local relief or other organizations. Thinning operations on too dense stands of second growth have also been carried on to the benefit of local populations, a contribution that will grow on federal refuge areas as the reforestation program continues.

Perhaps the most valuable future contribution of some of the refuges will be in providing seasonal work in harvesting surplus fur. This will apply especially to marshlands restored by diking. It has been found that a fairly heavy muskrat population is necessary on many marsh areas if they are to maintain high productivity. Too large a population, however, destroys the more desirable marsh vegetation and often leads to burrowing so extensive as to endanger the dikes. Sooner or later, therefore, it may become necessary to reduce the population of muskrats, or at least to prevent its further increase. This is often done by local trappers, and is of direct value to the community in providing work and distributing wages among many who would otherwise be idle. Such returns usually go to those in most urgent need of supplementary income. This contribution from lands not now productive of dollar values will be of growing importance in communities where these projects are located or may be established in the future.

CHAPTER III

Types of Refuges

Refuges can be of any size and may be devoted to a single purpose or to a combination of purposes. Any classification as to types must be somewhat arbitrary, hence it is just as well to adopt one based on original objectives. Confusion would result from any other plan, as the range of wildlife uses may assume a scope that could not have been foreseen. Most refuges contribute to the welfare of creatures other than those for which they were established. Wild creatures cannot read man's laws nor his signs, but they can recognize suitable food and cover and will use them regardless of the purpose for which these facilities were provided.

The preceding chapter emphasized the fact that the greatest value of refuges might well be the preservation of varied environments in which wildlife may continue to exist. This is a fundamental truth despite the fact that some ardent and sincere conservationists over-emphasize the value of preservation of individual birds or mammals rather than that of suitable living quarters for continuing animal populations.

It is difficult to understand how anyone can fail to realize that individuals are born to die. Eat and be eaten is a universal law of nature that may be read in the record Mother Nature writes each day. One who watches the constant interplay of living things must realize that a given individual is unimportant but that the survival of sufficient individuals to reproduce their kind is all-important in the biological sense. Hence arises the importance of the retention or restoration of environments in which considerable populations of the beneficiary species may live and reproduce.

The classification of refuges of the Fish and Wildlife Service is arbitrary and was made entirely for administrative convenience. It seems practical, however, as a basis of discussion of refuge types. Since federal refuges are so widely distributed, the classification doubtless covers rather comprehensively the possible types of refuges. The Service refuges are grouped as: (1) Special Pur-

pose for colonial non-game birds; (2) Big Game; (3) Migratory Waterfowl, and (4) General Wildlife.

SPECIAL-PURPOSE REFUGES

Special-purpose refuges are created for the protection of a single colony or group of colonies of birds or mammals. They may also be for the protection of a single species, although only one is now so designated. Such refuges are frequently, but not necessarily, small. The majority are islands either in coastal waters or in lakes that were set aside for the protection of non-game water birds. They vary from low sandy islets with or without vegetative cover to rocky pinnacles in whose crevices and crags seafowl find acceptable living quarters.

Pelican Island, the first federal refuge, was a sandy island used for nesting by a colony of brown pelicans. For many years the establishment of colonial bird refuges was a major project. This period coincided with the fight to stop plume-hunting which, to supply the demands of the millinery trade, was rapidly exterminating every species of colony-nesting bird for whose plumage a demand could be created. Colony after colony of gulls, terns, grebes, herons, egrets, and other species were wiped out. The crusade to stop this inhumanity stimulated and to some extent united the conservation forces, but more importantly revealed the inborn interest of the average citizen in anything concerning the out-of-doors.

Prompt action was necessary to stop the slaughter in time to save the birds and these refuges were rapidly established. While the Biological Survey had no funds for such work, private organizations and individuals contributed money to provide patrol during the breeding season in a coöperative endeavor that saved numerous colonies.

These special-purpose refuges provided safety for colonies of several birds that were near extinction. The enactment and enforcement of protective laws by an increasing number of states and finally by the federal government (Migratory Bird Treaty Act) gave the birds a chance to spread from the refuge havens into an increasing part of their former breeding territories. The egret and the snowy heron, once nearly extirpated, not by destruction of environment but by slaughter by plume hunters, now reoccupy much of their old breeding grounds. In increasing

numbers they make the annual post-breeding season pilgrimage beyond their breeding range, to the delight of thousands who enjoy their beauty. At times during July and August the waterfront parks and sea walls, as well as the shallow bars and shore lines of the Potomac River near Washington, are fringed with these decorative visitors. I have counted as many as a hundred in a single trip through Potomac Park—a sight to be credited to adequate protection on the breeding grounds. Such birds as the black skimmer, yellow-crowned night heron, least tern and others extirpated from northern coastal breeding grounds have again worked their way northward to suitable nesting spots on the coasts of Delaware, New Jersey, and Long Island in growing numbers.

Not all special-purpose refuges are federal. A number of states and various private organizations and individuals protect many other nesting colonies. The National Audubon Society has been especially active in protecting such birds and maintains several refuges policed by paid wardens. Hawk Mountain, a unique special refuge of which more will be said later, is the only owned and patrolled refuge of its kind known to me.

Another that deserves special mention is the Heath Hen Sanctuary, established and maintained by Massachusetts in a laudable but, as it proved, futile, attempt to preserve the bird for which it was named.

With rare exceptions federal refuges of this type protect such birds as herons, ibises, pelicans, gulls, terns, skimmers, auklets, murrelets, puffins, murres, shearwaters, fulmars, petrels and cormorants, although incidentally they may protect equally interesting associated species.

BIG-GAME REFUGES INCLUDING GAME RANGES

These refuges are for the purpose of protecting herds of big-game animals. The first federal area in this class was the National Bison Range, established in 1909. It was significant, not only as the forerunner of the system of big-game areas, but doubly so because its establishment marked the first appropriation of federal funds to create a refuge. The sequence of development of the major type of federal refuges follows the development of public interest in the groups of wildlife protected. First came those for the protection of plume-bearing

PLATE 5

INTERESTING AMERICANS FOR WHICH REFUGES ARE PROVIDED

Upper. Desert mountain sheep in Boulder Canyon National Wildlife Refuge.

Fish and Wildlife Service photograph by Robert E. Towle

Lower left. Brown pelicans find their northernmost nesting ground on Cape Romain National Wildlife Refuge.

Fish and Wildlife Service photograph by A. H. Du Pre

Lower right. A bull elk shedding the velvet from his antlers. Fort Niobrara National Wildlife Refuge.

Fish and Wildlife Service photograph by Geno Amundsen

PLATE 6

WHILE FIRE PROPERLY USED IS OFTEN VALUABLE IN MARSH MANAGEMENT, UNCONTROLLED FIRES ARE AS DESTRUCTIVE HERE AS ELSEWHERE

Upper. A bad marsh fire in the Sacramento Valley, California.
Fish and Wildlife Service photograph by Stanley G. Jewett

Lower left. Grass fires often start peat burns in dry lake beds. It will take many years to restore the productivity of this burned area.
Fish and Wildlife Service photograph by F. W. Ouradnik.
Mud Lake National Wildlife Refuge

Lower right. Mallard nest destroyed by fire.
Fish and Wildlife Service photograph by C. Cottam, Wheeler Migratory Bird Refuge

birds threatened with extinction; second were units for big game required by the depletion of these species. One reading the literature of about 1910–1912 can find only dire predictions of the prompt and inevitable extermination of all big game within a few years. Atlhough the first migratory waterfowl refuge was created in 1908, little public interest was manifested in the fate of these birds or in refuges for them until the swift decline in waterfowl numbers, which began about 1920 and became apparent to all but the most unobservant by 1928, had focused public attention on their plight. Most of the refuges for waterfowl have been established since that development.

There are sixteen federal big-game refuges at present. The program calls for acquisition of at least one unit in the natural habitat of each big-game form. This part of the refuge program is about half completed; hence an additional sixteen areas are needed to reach the minimum goal. A satisfactory big-game refuge should be large enough to provide adequate year-round food and cover and to allow scope for the normal movements of the species to be protected. It must provide sufficient forage and water for a herd large enough to insure perpetuation of the species. Federal refuges now provide for one or more nucleus herds of the bison, white-tailed and mule deer, elk, black deer, antelope, and mountain sheep. Important species not yet adequately provided for within the continental United States include the grizzly bear, moose, mountain goat, black-tailed deer, and caribou.

There are many more state than federal refuges that can be classified here and correspondingly fewer private refuges than in the special-purpose group. Since the great majority of state game agencies are entirely dependent upon receipts from hunting and fishing licenses for operating funds, they take care that the game, license holders' desire, shall not be depleted.

Many of the state big-game refuges are huge areas that were set aside by legislative action at a time when big-game herds were near local extinction. Undoubtedly they had a good effect in promoting the restoration of deer, elk, antelope, and black bear even though in many cases never adequately patrolled and sometimes not even posted sufficiently to mark their boundaries. These huge reservations, many of them larger than necessary under present conditions, account for much of the total acreage of game refuges listed in the chapter devoted to state refuges.

The game range is a modification of the big-game refuge which might better be termed a game-management area. Under this type of conservation activity, districts are closed—in other words, made refuges—for the purpose of building up depleted stocks of one or more game species. When these are replenished it is planned, as a rule, to open part, or perhaps all, of the closed area to hunting under a controlled hunting plan designed to assure a sustained annual yield of game.

The Fish and Wildlife Service has a few such areas on which various types of management are being tried and a very few on which experiments in developing harvesting techniques are now being carried out. Others will be opened to hunting under various experimental conditions when their game populations increase sufficiently. The chief value of these management areas is undoubtedly as laboratories in which it may be possible to discover improved and dependable methods of handling the game harvest.

A good proportion of the states are using Federal Aid in Wildlife Restoration funds to acquire and develop lands, or develop lands already owned, under this type of management. Numerous carefully planned experiments are now being tested on these lands. This appears to be a worthwhile modification of the refuge idea. In addition to restoring and maintaining stocks of game on the units, these experiments will develop knowledge and skills that can be widely applied in the management of game resources.

MIGRATORY WATERFOWL REFUGES

These refuges consist of lands or waters, or combined land and water areas on which can be maintained cover and food to meet the special needs of waterfowl. They may vary from natural lakes or marshes, or both, maintained and patrolled for the use of the birds, to those artifically developed where suitable cheap land and a water supply are available near enough together.

The greatest acreage of waterfowl refuge is federally owned. The reasons are: (1) the Migratory Bird Treaty Act makes the conservation of these birds a federal obligation; and (2) the Migratory Waterfowl Hunting Stamp Act, popularly known as the "Duck Stamp Act," provides funds for the development and maintenance of waterfowl refuges. Our treaty with Mexico also pledges the federal government to the "establishment of refuge

zones in which the taking of such birds will be prohibited." Further, a decline in upland game preceding that of waterfowl caused many states to expend their major efforts toward restoration of non-migratory wildlife for which they had sole responsibility.

There also existed a feeling, fortunately now greatly diminished, that if the federal government was to regulate the hunting of migratory waterfowl it should also care for them. No state, however, ever carried this feeling to the extreme of failing to demand a state hunting-license fee from those hunting ducks and geese. In recent years the states have realized more and more that they also have a great stake in these birds and have been devoting some of their resources to constructive work in behalf of the migratory waterfowl.

The passage (September 2, 1937) of the act providing Federal Aid to the States in Wildlife Restoration, widely known as the Pittman-Robertson Act, which made development funds available to a majority of the states for the first time, has further accelerated the establishment of waterfowl refuges or general wildlife areas in which waterfowl are given as much help as possible. Some of these state refuges are of exceptional value because of high quality or favorable location. There are comparatively few private refuges of this type, largely because of the character of the land needed, the difficulty of maintenance and patrol and the cost of restoration of water areas.

The federal migratory waterfowl refuge system, now about half developed in acreage and well over half started at established sites where some land has been acquired, has been planned to serve adequately the four major waterfowl flyways and the major concentrations of the birds in these flyways. The provision of effective refuges for these wandering birds is difficult. It is possible to assure the survival of resident forms by a single refuge of adequate size and suitable type, but similar insurance for an equal number of migratory waterfowl may require a chain of refuges along the whole Pacific and Atlantic coasts, or the entire length of the Rocky Mountains or the Mississippi Valley from the Canadian line to the Gulf of Mexico. At every major waterfowl crossroads and concentration point, adequate feeding and resting grounds must be provided to insure the safety of such long-distance travelers.

Waterfowl refuge fall into three natural classes: (1) breeding

areas; (2) resting and feeding areas; and (3) wintering grounds, all equally necessary to the welfare of the birds.

GENERAL WILDLIFE REFUGES

There are comparatively few federal general wildlife refuges, since the majority were created to meet special problems. Some, such as the Aleutian Islands, and Lake Mead above Boulder Dam are important. Among small areas, the Wilson Refuge in Georgia, containing among other attractions a beautiful lake and cypress swamp, and Chinsegut Hill in Florida, also fall in this class. These two were given to the federal government, the former by Dr. F. C. Wilson in 1939, and the latter by Colonel Raymond Robbins in 1932. These general areas are attractive to a great variety of small birds and mammals but this by no means indicates, that larger species do not visit them or that they are unwelcome when they appear.

General wildlife refuges are numerous in the state system and are also frequently maintained by private individuals who enjoy the presence of wild things about their homes or on their lands.

All that is necessary to provide such a refuge is to close the area to hunting, post the boundaries thoroughly, and furnish enough patrol to insure compliance with the trespass warnings. No extensive plantings are necessary, although the variety of life attracted may be increased by diversifying the vegetation. For example, general wildlife refuge in a pure stand of longleaf pine would attract and feed only the forms of birds and mammals adapted to live with the pine and its associated species. The addition of small groves of deciduous trees and clumps of shrubbery could confidently be expected to bring locally resident species associated with them. Construction of a pond or lake would eventually result in the addition of water-loving forms to the fauna.

Many private refuges, though small home sites, contribute measurably to the welfare of small-bird populations and furnish much pleasure to their operators. In many cases artificial feeding of grains, fruit, suet, and other things attract additional species, as well as more individuals of the species already present. This is a practice widely followed in city and suburban areas; it is advisable only if continued as long as needed. Feeding only

part way through the winter may attract birds away from natural food supplies to which it is difficult or impossible for them to return under emergency conditions. If the feeding stops at such a time many of the birds perish and it would be better not to start than to handle the matter in so cruel a fashion.

Federal refuges follow a definite policy of discouraging artificial feeding as a regular practice. It may be used temporarily to attract waterfowl to a newly flooded area, and a supply of food is kept on hand for emergency use where large concentrations of wildlife make it advisable.

CHAPTER IV

Management of Refuges

It should be understood that the management practice outlined in this chapter may soon be obsolete. Only within comparatively recent years has personnel been available to plan scientific management and test practices on an adequate scale. In no field of conservation is knowledge advancing more rapidly or field practices changing more frequently; hence this chapter can be only tentative, based on today's knowledge.

BASIC CONCEPTS

The basic concepts for the management of federal refuges are that: (1) all wildlife should be protected; (2) refuge lands should be developed to afford maximum wildlife use; and (3) in developing management practices wildlife and its needs should always be considered first.

The first principle seems obvious, but like many other obvious statements it requires clarification and modification. All wildlife should be protected but not to the extent of impairing the value of the refuge or of neighboring holdings. If deer or elk increases on a refuge, invade nearby agricultural lands, and seriously damage crops, justifiable complaints will arise. Such species may also become so abundant as to destroy progressively the food plants on which their own existence depends. For such reasons good management may require reduction in numbers of animals, even of kinds the refuge was designed to protect.

Predatory forms may become so abundant that they consume too large a proportion of animals which it is especially desired to preserve. Other creatures may destroy needed food and cover and again reduction of the offending populations may be the only remedy. Needless to say, such reduction should be done with care and never to the point of extirpation.

One of the greatest obstacles to proper application of control lies in human frailties of the management personnel. For exam-

ple, a person charged with the care of a herd of antelopes on a refuge established for their protection may become so intensely interested in the animals as to desire to destroy every other form of life that competes with them for food, or that kills, or even has the potential ability to kill, an antelope. Managers charged with the care of a breeding waterfowl population may develop a similar attitude toward their charges. It is seldom that prejudices reach such extremes, although it has occurred. There is always the possibility that such feelings may develop and result in the adoption of control practices where none are justified or needed.

For the purpose of limiting control to that actually justified, it is a fixed policy of the Fish and Wildlife Service to require advance authorization from the administrative office before control is instituted. Such permission is granted only when concrete evidence seems to warrant it. Such control as is permitted is based largely on careful investigations by biologists entirely detached and independent of the refuge administration.

The second basic concept—that of developing maximum use by wildlife—needs little elaboration. One of the chief causes of decline of many species has been constant decrease of the area of their habitats. Conversely, one of the main problems has been to keep that which remains and, so far as possible in the face of increasing human occupation, to restore land to wildlife use. It seems desirable, therefore, to make lands administered primarily for wildlife as useful and productive as possible. This can be accomplished by a variety of management practices outlined in succeeding pages.

The third principle—that of keeping wildlife needs first in the management of an area—is also obvious, but in practice often requires exceptional judgment. In administering some lands it has been found that mowing and grazing can be used as tools to maintain the ecological conditions best adapted to the needs of the more important wildlife on the refuge. Yet, wherever these privileges are allowed, local pressure may develop to extend them so that they would cease to be incidental but would become dominant. Similarly, removal of muskrats, sometimes necessary to protect dikes or to prevent destruction of aquatic plants needed for waterfowl, may easily become, through local pressure for trapping privileges, a major use rather than a practice for the betterment of wildlife environment or for protection of the refuge.

Similar problems often confront the refuge manager and he must exercise judgment and diplomacy in solving them.

Employing adequately trained personnel, and checking their work to detect mistakes in judgment before they assume serious proportions is the only possible way to achieve good administration. This statement is easy to make but to carry it out is endlessly difficult.

GENERAL MANAGEMENT PRACTICES

There are certain management practices that apply more or less to all types of refuges and to the majority of the individual units as well.

When a refuge is established, the first essential is adequate marking of the boundaries and posting of proper notices. Refuges without these warnings against trespass are of little value, the only exceptions being islands so remote that there is little or no chance of their being unwittingly invaded. Prevention of the deliberate poaching that exists in some degree whenever the incentive is strong enough, regardless of marking and posting, is another problem. The posting of conspicuous notices at the best landing places on island refuges is usually considered sufficient to prevent accidental trespass. In wooded areas, brushing out of boundary lines, followed by stringing a single strand of smooth wire is in common use. Refuges in rough, thinly populated country can usually be adequately posted by placing markers on all approach roads, trails, and ridges and in open stream bottoms. In flatter, more thickly settled areas, fencing, and the posting of conspicuous signs at frequent intervals, are sometimes necessary to afford a similar degree of protection. On national refuges, under these conditions, the practice is to post refuge signs at quarter-mile intervals, sometimes even nearer together if the contour of the land makes it advisable.

The second general administrative necessity is patrol adequate to insure the refuge against both accidental and intentional trespass. Such a protective system is never perfect but it should be good enough to keep invasion at a minimum. Where game species are concerned, patrol is most necessary during the hunting season and for colony-nesting species during the breeding period. The intensity of patrol must of necessity vary with the type of refuge, contour of land, and attitude of the human population toward

the refuge. The wise manager endeavors to work with local leaders to acquaint them with the purposes and value of the refuge, to help solve local problems occasioned by its presence, and to make it appeal to local pride. Maintaining good public relations is often the most effective protection.

Fencing—the third basic management requirement—is needed on many, but not all, refuges. It is necessary where big game must be confined to a definite area, as on bison ranges. Except for boundary marking and patrol, it is the most important requirement on waterfowl breeding grounds in districts where livestock ranges, and less necessary but often needed on big-game or upland refuge areas in cattle or sheep-range country. Even where limited grazing has been found desirable, fencing may be necessary in order that the grazing may be confined to the proper season and limited to the desired intensity. It must be remembered that the area is being administered for wildlife and that any grazing permitted should be for the benefit of wildlife management rather than for cattle or the cattle industry. Substantial fencing is desirable also on refuges near dense human populations. Stout fences act as a deterrent to many and leave those who trespass deliberately without the excuse, "I didn't know where the line was."

Proper management of all refuge use is required to maintain or restore desired vegetation. This is the fourth general precept followed by administrative personnel. On big-game ranges it may be, and to date usually has been, necessary to reduce use in order to assure recovery of vegetation. This is especially true on refuges in semi-arid lands. Management is directed toward the maintenance of a balanced vegetative cover unless there are definite reasons for favoring some one plant or group of plants. Grazing, mowing, burning in some cases, seeding, and planting of shrubs and trees, are some of the practices the refuge manager uses to accomplish this purpose. On forested lands, thinning, cutting, and replanting with an eye to wildlife needs, rather than to ideal forestry requirements are practiced. Thus, the wildlife manager may plant shrubs or even trees that help overcome some deficiency in cover or food supply rather than use the trees that might produce the finest timber in that locality.

On marshlands efforts often are made to limit cattails, alligator weed, sawgrass, and other plants having low wildlife values and to encourage the spread of the more desirable bulrushes,

three-squares, smartweeds, pondweeds, and other favored food plants of both submerged and emergent types. This is accomplished by manipulating water levels, plowing or burning marshes when dry, and mowing aquatic plants with underwater cutters, or by a combination of these and other methods. In areas to be flooded, spot planting, either of roots or seeds of desired plants often gives them a start over other less desirable indigenous growths. This practice is followed to the extent that seeds and tubers are available.

The fifth general management practice is protection from fire. Provision of fire lanes, and adequate fire-fighting equipment together with men trained in its use, is necessary on many reservations. Only those refuges that are largely water or on which vegetation is so scant or so non-inflammable as to be a limited hazard, are exempt from this requirement. This is true even where fire has been found to be useful in management. Fire at the wrong season can be just as destructive on such units as on any others. To be valuable as a tool, fire must be controlled in intensity, and used at the right season and under proper conditions.

The sixth and last general requirement in refuge management is the maintenance of proper relationships between wildlife species using an area. The problem presented by these relationships are often complex and can be solved only after careful study. In recent years the Fish and Wildlife Service has kept a staff of biologists working on the principal basic problems that have become apparent as a continent-wide system of refuges has come under administration.

One of the most interesting of these has been the handling of muskrat populations. It has long been known that muskrats and dikes do not always go well together. However, the fact that a fairly heavy population of muskrats tends to keep down certain plant forms and permit the growth of others has not been so widely appreciated. Muskrats in their feeding activities also make channels and openings in dense stands of vegetation and thus render them more usable by waterfowl; and finally, they construct lodges that are often used by geese, ducks, and other water birds for nesting sites. An overpopulation of muskrats may destroy too much of the vegetation of a marsh and, in extreme cases, contribute to objectionable erosion by wave action. Through judicious trapping, however, muskrat populations may be regulated

not only to their own best advantage but to that of maintenance or improvement of the marsh itself.

The vital relationship between all gregarious browsing species and their food plants has been repeatedly emphasized. Every manager of lands supporting deer, elk, or antelope knows well that a reasonable balance between the size of the herd and the annual growth of browse must be maintained to avoid serious trouble. The wise manager starts work on the problem before it becomes pressing; he does not wait for a crisis to develop.

Recent studies have indicated strongly that the type and extent of vegetative stands in marshes have a direct influence upon the number and kinds of waterfowl nests. Therefore it is possible, to the extent that the vegetative types can be manipulated, to favor desired species. Conversely, marshes unmanaged or mismanaged can easily pass from a highly productive to a less productive condition.

MANAGEMENT OF REFUGE TYPES

In addition to general management principles of wide application, there are others that pertain only to certain types of refuges. Objectives and practices that may be entirely desirable under one set of conditions may be wholly undesirable under others. It is necessary, therefore, to discuss in somewhat greater detail additional practices that may apply to specific types of refuges. On these it is assumed also that all of the standard practices are used so far as they are suitable.

Special-Purpose Refuges

Refuges protecting breeding colonies of nesting birds usually consist (in the federal system) of the contrasting classes of high islets and low sandy islands. On many of them little management is possible. There is little that can be done to improve a towering pinnacle of rock whose ledges and crevices are used as breeding places for birds that obtain their food from the surrounding waters. Many of the low sandy islands are equally unsusceptible to management. An occasional invasion of rats, raccoons, or other small predators on such islands may call for control to prevent destruction of the colony.

Pelicans, herons, and egrets frequently leave refuges and nest

on unprotected areas. Up to the present the only management possible in such instances has been to move the refuge with the birds if practicable. The reason for this behavior is unknown, although the theory has been advanced that accumulation of guano, killing the trees used by these colonies, makes moving desirable. Another possible reason may be increase in vermin and parasites.

One interesting practice affecting colonial species has been the development of artifically induced colonies. The most successful example of this has been Bird City, Avery Island, Louisiana, which will be discussed in a subsequent chapter.

Big-Game Refuges

Big-game refuges are of two kinds, those under fence where the herds are under complete control, and open ranges where the animals are free to come and go.

The national big-game refuges established to preserve natural homes for nucleus herds have, through their success, come to be looked upon as sources of animals for restocking depleted areas. It is the policy, therefore, to trap surplus individuals and move them wherever wanted. Each year numbers of bison, elk, deer, and antelope are taken for restocking purposes from both fenced and unfenced refuges.

The chief concern of every big-game refuge manager is to keep his herd in balance with the available food supply. On fenced areas this is comparatively easy, as the animals are so under control that it is possible to cull the herds almost as easily and accurately as a farmer does his dairy or beef cattle.

On unfenced areas the problem is more difficult. Nevertheless, hundreds of deer are trapped annually on such refuges as the Aransas in Texas, Blackbeard Island in Georgia, and Bull Island in South Carolina and released on lands where the deer populations are low. Smaller numbers of elk and antelope are annually transferred in similar fashion from western game ranges. Turkeys, quail, and ring-necked pheasants also are taken from well-stocked refuges for release on less favored areas. Only as a last resort, where sufficient demand for the animals alive is not manifested or where the increase is so rapid that trapping cannot keep pace with it, is any killing done.

Special management practices are few on the big semi-arid

game ranges of the West. Most of these refuges were badly overgrazed lands which, above all, needed revegetation. This is being encouraged by reducing livestock use, thus allowing recovery of the aspen, white sage, bitter brush, and other plants that are staple game foods.

Achieving better distribution of water by building dams to catch run-off has proved to be a practical device for scattering animals and obtaining a more even distribution of grazing and browsing pressure. Altogether scores of "tanks" or small ponds have been built but many more are needed. The dams should be substantial and impound water to a depth sufficient to last throughout the season. There is an annual evaporation of three to five feet on some of the western refuges; hence, the depth of water tanks there should exceed that figure by a margin that insures water remaining throughout the season.

In some cases the basin behind the dam is large enough for a fair-sized lake or marsh for waterfowl. On each of the two great antelope ranges, Hart Mountain and Charles Sheldon, water is available to create and maintain several thousand acres of marsh. Some of the units already constructed have proved attractive to waterfowl and, on a per acre basis, produce more broods than many of the larger refuge marshes. These water developments encourage a better distribution of the antelopes over the refuge and at the same time conform to the basic concept of contributing to maximum wildlife use.

The chief concern of management on timbered big-game refuge is to overcome the comparative scarcity of plants that are most useful to wildlife. Those that furnish food in late winter and early spring are most often needed in greater abundance and the efforts of managers are directed toward increasing them. Most federal refuges that include woodland have been cut or burned over, and some are already well covered with second growth. Cutting or clearing operations, whatever the primary purpose, can often be made also to favor desirable plants. Controlled burning in some sections and agricultural use of open areas often make more favorable conditions for wildlife. To the extent possible, these practices are followed as the most feasible ones now known. Planting of seeds or seedlings can be resorted to but the scarcity of planting stock is a handicap. In recent years the Fish and Wildlife Service has collected seeds of such trees and shrubs and either grown the desired stocks or furnished the seed for

growing to the well-equipped nurseries of the Forest Service and the Soil Conservation Service.

It has also been frequently found desirable to build interior roads and trails for patrol purposes in big-game refuges, although this is something that can be easily overdone as traffic should not be encouraged. For another reason it may also be carried too far and overenthusiastic managers have learned to their regret after hasty construction that maintenance funds are not always available.

Migratory Waterfowl Refuges

The management of migratory waterfowl refuges requires good judgment and a knowledge of the requirements of marsh and water plants. It is hopeless to attempt to discuss here the details of management practiced throughout the nation, so it seems better to define the objectives of the three types of waterfowl refuges and to outline the principal measures available for their management.

Breeding-ground refuges, located in the northern states or in the mountainous districts of the West have in general the same problems. Some are former wet areas spoiled by years of drought or by drainage; others may never have been watered. The objective of the program has been to put low-priced land and water together wherever possible, either to restore old lakes and marshes or to create new ones that would replace in part the millions of acres of ancestral breeding grounds no longer available to the birds.

In some instances, plant growth, although not always of a desirable type, followed flooding; in others it did not. It was quickly found, however, that spot planting hastened revegetation and, using the more valuable plants, results were better than from natural seeding. Studies on various breeding marshes by investigators of the Fish and Wildlife Service have shown that some birds have definite preferences for nesting in stands of certain kinds of plants. For example, the Canada goose and the redhead, mallard, and ruddy duck nested by choice among hardstem bulrushes at Bear River Refuge, while the gadwall, cinnamon teal, pintail, and shoveller resorted more to willow and weed growths. These preferences are marked enough to indicate that the relative acreages of various aquatic plants decidedly influence the makeup of the waterfowl population, as well as the

numerical ratios that exist between the species on any definite marsh area.

The prime requirement of breeding areas is a stable water level from May to August. When the water rises suddenly in May and June, it floods and destroys many duck nests. Rapid fall in July and early August, leaving nests stranded far from permanent water, may result in the death of many ducklings. Both hazards occur in one district or another every year. When they become widespread, they take an enormous toll that may seriously deplete the duck crop. Of the two catastrophes the second is the worst. Pairs whose nests are flooded out, unless it is very late in the season, usually lay a second though smaller clutch of eggs, but there is no appreciable replacement of the young birds lost by the drying up of marshes and sloughs. Efforts have been made, therefore, to plan restoration projects so as to hold such losses to a minimum. Whenever possible one or more storage reservoirs are constructed at the upper end of a refuge. These have a two-fold use. First, they are designed to catch the flash run-off that may come from May and June storms and to limit destructive effects by confining it to the storage unit. Second, the storage water is fed out as needed to offset evaporation in the marshes below to prevent their drying out. Where such storage is not possible, effort is made to hold water with dikes and dams on at least part of the flooded area to a depth greater than the evaporation loss.

Control of water level is an important, perhaps the most important, management tool during the breeding season. It is of value not only in assuring and safeguarding the waterfowl crop but also in controlling the types of food available for the young birds.

Water plants are so sensitive to changes in water levels that it is possible to change entirely the vegetation of a marsh by variations of a few inches. Many of the submerged aquatics of greatest importance in duck-breeding marshes are particularly responsive to such changes. Some of them are practically indispensable to ducklings; hence, preserving them is a vital reason for reducing water fluctuation to minimum during the growing season.

The marsh that is one vast unbroken expanse is not the most productive. Broken up into a medley of small ponds, sloughs, lakes, and channels, interspersed with islands, points, and ridges,

the same area will be much more productive. A proportion of about 40 per cent land to 60 per cent water has proved successful. In general, the greater the length of shore line, the larger the number of duck nests. Accordingly, engineers, in fixing water levels, take advantage of local topography to create the maximum number of islands and the greatest irregularity of shore line.

The alert refuge manager always seizes favorable opportunities for seeding or for transplanting rootstocks to increase the areas of plants found to be most desirable in his area at the expense of those less valuable. For example, hard-stem bulrush is often preferred to cattails in breeding areas. The bulrush, once established, can compete fairly well with the cattail but cannot invade dense stands of the less valuable plant. Hence, the manager discourages the cattail and helps the bulrush by every possible means. This may be accomplished by seasonal manipulation of the water level, by burning the cattail, by mowing it under water, or even by plowing where it is possible to dewater for a time a badly grown up unit. The bulrush can be aided by maintaining the most favorable depth of water for it during the growing period and by planting it on new ground to give it a start over the cattail.

Muskrats feed extensively on the roots of cattails and are useful in maintaining openings in areas that would otherwise grow up solidly to these plants and become of little use to ducks. They also keep the stands thinned out enough to permit more interspersed growth of valuable submerged aquatic plants than would otherwise occur. The maintenance of a muskrat population at the most desirable level is one of the goals at which managers aim. That level can be ascertained only by several years' careful observation of the area and the effects of muskrat activities upon it. Such studies have now been under way for several seasons on many refuges and attempts to manipulate populations of muskrats are under way.

In acquiring land for waterfowl refuges, effort is always made to get a liberal margin of land to provide nesting cover, to insure against reflooded areas waterlogging privately owned properties, and to facilitate patrol and protection. Such marginal land is often grassland or ground that eventually develops into grassland. Small parcels of it are sometimes good agricultural land. These may later be planted to food-producing plants by the refuge personnel or farmed on a share basis with a neighbor. In

PLATE 7

SMALL WATER HOLES HELP GREATLY IN DISTRIBUTING LIFE OVER AN AREA

Upper. Seepage filled this pond in Valentine National Wildlife Refuge soon after excavation was completed.

Fish and Wildlife Service photograph by Ward M. Sharp

Lower. Antelope regularly water on the Charles Sheldon Antelope Range at this and other water holes created by small dams below springs or in erratic stream beds.

Fish and Wildlife Service photograph by E. J. Greenwalt

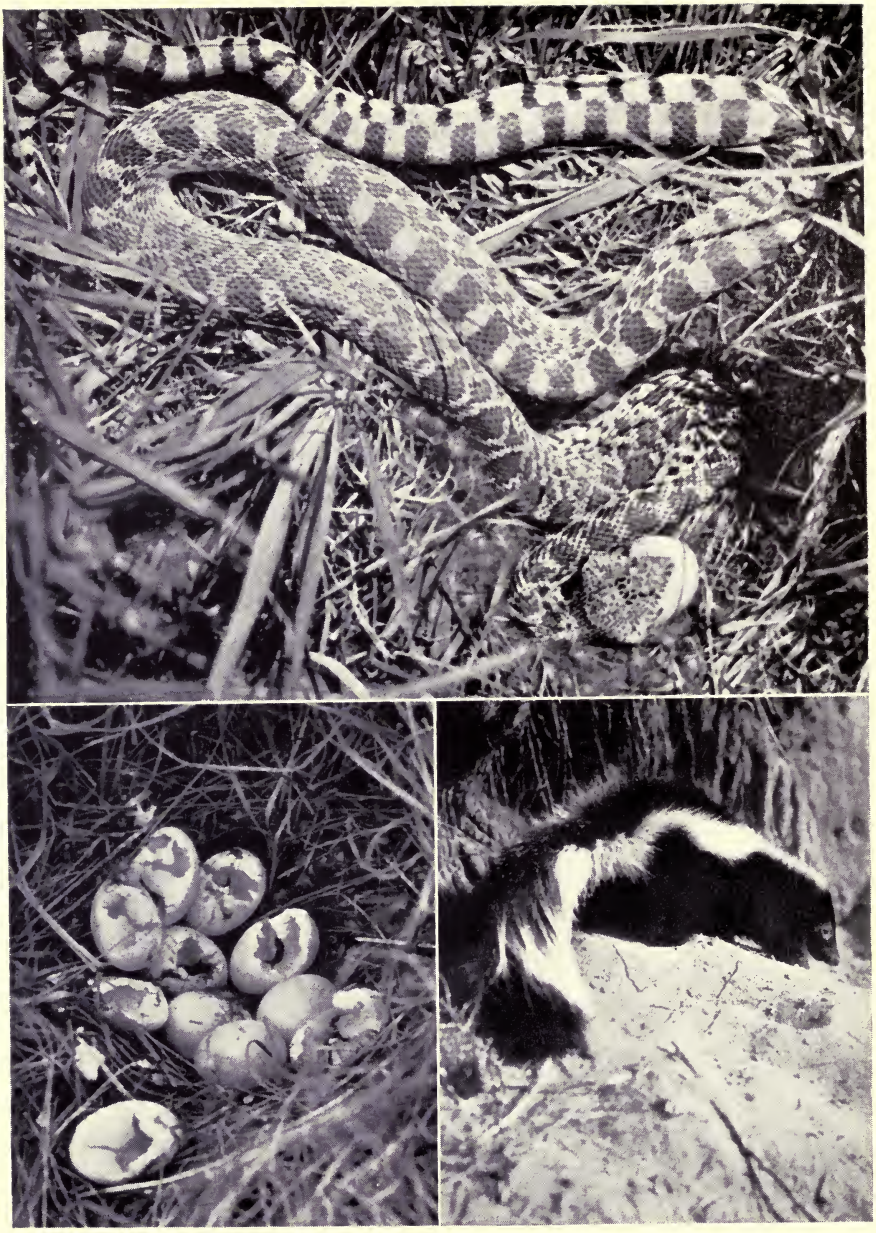

PLATE 8

WILDLIFE HAS DIFFICULTIES EVEN ON REFUGES

Upper. The last of nine shoveller eggs is going down this bullsnake's throat.

Lower left. Blue-winged teal nest destroyed by a skunk.

Lower right. Skunks take a heavy toll of eggs.

Fish and Wildlife Service photographs by Ward M. Sharp, Valentine National Wildlife Refuge

order to provide early spring food for northbound geese, it has been found desirable to plant rye or other fall crops. Where such plants do not thrive, late summer or winter burning or mowing of grasslands may bring tender vegetative growth earlier in the spring. Thus, mowing for hay may fit into the wildlife management program. Needless to say, however, the date for mowing is set by the manager at a time after the nesting season. A considerable scope of country may be involved, especially where mallards or pintails are nesting, as these birds often lay their eggs a mile or more from the water's edge.

The predator problem is ever present. Where and to what extent control is necessary or desirable are among the greatest problems facing administrative personnel. Experience and research have shown that decisions as to control should be made on a local basis. On a given refuge any one of such predators as crows, bull snakes, skunks, ravens, or coyotes may be destructive enough to require control, while on another in the same region no control may be necessary, or if needed it is for entirely different predators. The effects of flesh eaters also vary from year to year on the same refuge. During one year, crows may steal many duck eggs; next year on the same area skunks may be the chief culprits. On refuges established primarily for waterfowl the exercises of reasonable control of serious predation is definitely indicated. However, in order to keep such control commensurate with the need, factual studies are being continually carried out by trained biologists. It is hoped, when many of these studies have been made and recorded, that some basic principle or concept will emerge, which will permit more rapid and accurate appraisal of the needs for control.

The broad, shallow marshes, typical of waterfowl refuges, are seldom of great value for fishing although the storage reservoirs may be. Wherever possible the welfare of fishes is also provided for—again following the concept of the greatest possible wildlife use. On refuges with fishes abundant enough to justify it, fishing is permitted in accordance with State laws and regulations. If necessary sections of the refuge most valuable for nesting or the entire area may be closed to fishing during the breeding season.

Flyway refuges present a somewhat different set of problems. They are managed, not to produce suitable food and cover in spring and summer for breeding birds and their young, but to

grow, ripen, and keep available in the fall and spring maximum quantities of food valuable for migrants. It is not so important on these areas to have variety of food-producing and other vegetation as it is to provide quantities sufficient to feed the flocks during a comparatively short stay.

Because of this different objective, stabilized summer water levels are not always necessary. In fact in some areas they are not desirable. It is possible to grow great quantities of seeds of wild millet and smartweeds and tubers of nut grass on wet lands that are not flooded during the summer, although flooding in the fall is necessary in order that the birds may fully utilized the food supply. If such plants fail to produce a satisfactory yield of food per acre, it may be possible to replace them with grain grown for fall flooding. Where the water level can be kept down during the summer and raised enough in fall to cover the surface to the depth of a few inches, maximum feeding values can be maintained.

Management of flyway refuges differs in other important respects. Hay cutting and grazing are not so often found to be useful. Because of the fluctuating water levels on most refuges of this class, it is not possible to maintain large stocks of either muskrats or fishes. Predator control, as a protection for ducks and geese, is usually unnecessary. Studies to date indicate that there is no significant loss of waterfowl from predation, after the birds reach maturity.

One real problem on lands subjected to alternate flooding and drying is the strong tendency for willows, buttonbush, and other moisture-loving shrubs, to take over and form dense thickets. These growths shade out and replace more desirable plants and may eventually largely destroy the value of an area for waterfowl. If the water can be sufficiently withdrawn to permit plowing once in several years, the woody plant invasion is greatly retarded and in some instances may even be terminated. Where water is available to reflood promptly to the depth of a few inches after the smartweed or wild millet is well above the ground, releasing it also helps to discourage growth of brush. Where water manipulation is not feasible, laborious hand removal may be the only way of keeping the land clear. On one refuge an ingenious manager got rid of a dense stand of willow poles by opening it up, a section at a time, to neighboring farmers for cutting for wood and other uses.

Wintering refuges to some extent require a combination of the methods of management used on the other types. Stabilization of water levels in summer is not necessary but the land must be flooded during the winter. Like the flyway reservations, winter refuges are managed to produce quantities of a limited number of foods rather than a great variety. The food must be available during December, January, and February, but its composition may vary widely in different sections of the country. Three-square sedge is a staple food in certain Atlantic and Gulf coast and western wintering grounds. The delta duck potato, of the arrowhead family, which has highly nutritious tubers, is particularly important in Louisiana. In salt water, ellgrass, and in brackish waters, widgeon grass, sago pondweed, and other submerged aquatics may be the most important sources of food. In the White River bottoms, Arkansas, acorns are the staple food. Some of the wintering refuges also depend to a considerable extent for their value upon wild millet, smartweed, and nutgrass where a summer drawdown and late fall reflooding are possible.

On many of the coastal marshes, grazing and fire are useful in maintaining desirable marsh conditions, but they must be used at different seasons and for widely different purposes from those recommended for handling grazing and haying on the breeding grounds.

At White River management of the food resources consists fundamentally in sparing oaks in the timber-cutting program. This is supplemented by manipulation of water levels to encourage production of more aquatic food plants in the 162 bottomland lakes which dot the area. On the coastal marshes of Louisiana, burning in late fall induces new, succulent growth to sprout, quickly providing food for the wintering geese. Grazing is valuable on a number of these areas in holding down vegetation that would otherwise grow into such a tangle as to be unusable by the birds. Burning over lands on which the three-square sedge was being crowded out by more aggressive but less desirable plants has in some places had the effect of restoring the preferred vegetation.

On some of the wintering refuges it has proved useful to expand the area of fresh or brakish marsh by impounding runoff or rainfall behind low dikes along the inner margins of the salt marsh. Such impoundments may produce several times the amount of food per acre as that available in a straight salt marsh

of cord grass. While this latter plant yields acceptable food for some birds, the supply is so much more than is needed that efforts to replace part of it with plants useful to a greater number of waterfowl are thoroughly justified.

Predator problems here, as on the flyway refuges, are of minor importance or absent.

It would be possible to extend this chapter greatly by going into the details of management. Enough has been said, however, to outline management objectives on sanctuaries, to indicate the major practices used to accomplish these objectives, to show the need for additional research into management problems, and above all to indicate the multitude of problems that must be faced in the everyday life of a refuge manager.

CHAPTER V

Alaska's Great Bird Cities *

It is a privilege to view the bird colonies along the coast of Alaska and on the islands of Bering Sea. Published information regarding most of them is meager compared with that available for the populous rookeries on the Three Arch Rocks off the Oregon coast, for some of the large gull and tern colonies of the continental United States, and for the vast populations of gannets, murres, and other seafowl on the famous bird rocks of eastern Canada.

The Alaskan bird cities are scattered from Ketchikan to Bering Straits and to spend a single day at each would require a trip of many weeks. Some are wildlife refuges; others are not. Two, Forrester Island and Hazy Island on the southern coast, are wooded islands whose cliffs and slopes furnish homes for thriving colonies of murres, puffins, auklets, gulls, and cormorants, but they are small compared to those farther west and north.

The aggregations of birds, scattered from Cook Inlet along the Alaska peninsula, throughout the Aleutians, and on the islands in Bering Sea, dwarf any others in North America. After seeing some of these colonies, one can hardly disbelieve any tale, however, wondrous as to the bird numbers.

The birds are by no means confined to the large colonies but inhabit every cliff and almost every pinnacle of rock in all the bays and channels along hundreds of miles of rockbound coast. Everywhere there are murres, which probably out-number all of the other birds. Their numbers vary from a few dozen pairs on some isolated rock to colonies where population estimates seemingly need be limited only by the observer's imagination.

Cormorants of three species are present in numerous small groups, but nowhere do their colonies compare in size with the great concentrations of murres, puffins, petrels, auklets, kittiwakes, and glaucous-winged gulls. Of the cormorants—white-

* This chapter is rewritten from an article appearing in *Bird-Lore* (**42**: 497–506; **43**: 15–23) and is used with the permission of that magazine.

crested, pelagic, and red-faced—the last named is found only on Bogoslof Island, in the Aleutians and on the Pribilof Islands. Most widely ranging is the pelagic, which occurs in moderate numbers around every rocky island from Dixon's Entrance to Bering Sea.

The grotesque puffins are likewise widely distributed throughout the territory. Tufted puffins are among the first birds one sees after reaching Alaskan waters and a few pairs can be found as far north as St. Matthew Island. Horned puffins are scarce until Kodiak Island is reached, but from that point on north these odd-looking little fellows appear in increasing numbers until in Bering Sea they usually far outnumber the tufted species.

Here it is practicable to mention only the greater concentrations of seafowl, and for convenience these will be discussed in geographic order from south to north and west. Passing the Copper River Flats—an area a hundred miles or more in length with intricate channels, sloughs, and marshes and a tremendous population of nesting gulls, terns, ducks, geese, and other birds—the first big bird colony the traveler will find is on Resurrection Point, at the entrance to the bay on which Seward, Alaska, is located. Here, on a sheer wall of rock rising several hundred feet from the water, an enormous aggregation of Pacific kittiwakes and California murres make their homes. The kittiwakes are the more abundant. While the cliff is white with the brooding birds, one can see comparatively few of their nests. They are built of bits of seaweed and other vegetation on the smaller shelves of this great cliff, which is inaccessible except by means of ropes let down from the top. The larger ledges are occupied by the murres and glaucous-winged gulls.

Deep water makes it possible for even a large vessel to drift almost to the base of the cliff, where one has an excellent opportunity to watch the birds. As the ship nears the murres, it is interesting to see the birds dive into the clear bay and, literally by flying under water, come up on the other side of the boat. Then they dive again, only to burst out some distance away, on the wing or to flop along the surface while getting breath for another dive.

The kittiwakes keep up such a continual chatter that ordinary speech cannot be heard. These are Pacific kittiwakes, one of the most beautiful of gulls, their clear white general plumage, with darker mantle and solid black wing-tips, forming a contrast with

the blue of the sky and brown of the rock that makes an unforgettable picture.

In addition to the kittiwakes and murres, cormorants, puffins, and glaucous-winged gulls nest in small numbers on the higher parts of Resurrection Point. Gulls accompany every bird colony—apparently for predatory purposes, as they pounce upon the eggs or young of other species whenever the colony is disturbed. Visitors should be careful, therefore, to cause as little disturbance as possible.

Across the Kenai Peninsula in the waters of Cook Inlet, the Tuxedni Refuge shelters another large colony of Pacific kittiwakes. A cliff extending along the southern part of Chisik Island harbors a rookery of kittiwakes at least two miles in length. Like all the other kittiwake colonies, it has the usual accompaniments of murres, glaucous-winged gulls, and other species.

After leaving Seward great numbers of Pacific fulmars appear over the waters north of Afognak Island, working out from a colony on Sea Otter Island, which is difficult to approach because of numerous submerged rocks.

On rocky islets about Kodiak Island little groups of glaucous-winged gulls and tufted puffins, and occasional pairs of horned puffins, cormorants, and murres nest and on the shore are often found black oyster-catchers, song sparrows and other birds. But the greatest concentration of bird life in this district is one of kittiwakes on Whale Island in the passage between Kodiak and Afognak islands. This colony, one of the largest in Alaska, containing many thousands of pairs extends for a mile or more along a cliff.

The Semidi Islands lie west of Kodiak and south of the Alaska peninsula. There are seven or eight in the group, besides numerous small rocks. The major bird attraction is an enormous colony of Pacific fulmars. Great numbers of them occupy at least four of the islands, using sheer cliffs for nesting sites.

On these islands, which are a federal wildlife refuge, eider ducks breed in numbers. Harlequin ducks also are common, not only here but elsewhere about the rocky islands along hundreds of miles of coast line. There are no great concentrations of either of these ducks, but both can be seen in some numbers every day.

The Semidis shelter numerous horned puffins at the most southern locality where they are more abundant than their larger tufted cousins. They are not found in compact colonies but in

scattered pairs, nesting in burrows along the tops of the cliffs. Pacific kittiwakes are common and California murres are present in thousands. Both the white-crested and the pelagic cormorants are found here in considerable numbers.

A huge sea-lion rookery occupies one of the small islands at the southern end of the Semidis and smaller numbers of these animals are found on every island in the group. These islands are a valuable habitat not only for the sea birds and mammals but also for small land birds. A few of the diminutive Semidi wren, a form intermediate between the winter wren of Kodiak and the larger form of the Aleutian chain to the west are present, and Aleutian rosy finches, Pribilof snow buntings, and savannah, fox, and song sparrows are common.

The Semidis have tundra of the dry type on the slopes and tops of the hills, and, like all of the islands to the north and west, support a stand of rye grass waist high, or higher, on all the beaches. It is hard to realize how difficult walking in this grass can be—it has been undisturbed year after year, dead stalks have accumulated, making an almost impenetrable tangle through which one must force a way. Going up hill in it, even for a short distance, is exceedingly tiring. Once through the rye grass, travel is somewhat easier, although the tundra is a springy mass of vegetation into which a person usually sinks to the ankles and sometimes almost to the knees.

From the Semidis westward, there are many small islands along the base of the Alaska peninsula. Nesting seafowl of the kinds previously mentioned are everywhere. Numerous small colonies of Arctic terns, occasionally mixed with glaucous-winged gulls or other forms, are present. Every island has something of interest to see but no great colonies lie close to the beaten track until one passes west of Dutch Harbor.

Some sixty miles north and west of Dutch Harbor lies Bogoslof, an island with a famous history of volcanic action. At the present time it seems to be substantial enough in spite of the disappearing act with which it is credited. Bogoslof consists of two rather small volcanic cones, or remnants of them, connected by a low flat island of several acres. It is famous for its sea-lion herds, which are fully up to advance notices. Three large herds occupy all available beaches. We saw a young pup lying beside the nest of the glaucous-winged gull containing three eggs. The nest, on a small low shelf, not more than six inches above the

level of the beach, had not been disturbed despite the fact that it was in the midst of this herd of large animals.

Climbing the thirty-foot cliff back of the sea-lion beach, one sees a great spectacle. The foreground, sloping gently up to the volcanic cones, is covered with glaucous-winged gull nests in all stages, from those with eggs to others containing half-grown young. Hundreds are in sight, together with adult birds on the nests, on the ground between, or wheeling and circling in the air overhead. This is one colony through which a visitor can pass without worrying about the effect of the disturbance as there are no marauders to take the eggs or young of these birds that are such eager predators upon other species under similar circumstances.

The first rocky pinnacle looming ahead is covered with birds. The closer it is approached the more one realizes how weak is the phrase "literally covered" when applied to a bird rock. The pinnacle itself is broken and weathered with many shelves and ledges, each lined with serried ranks of Pallas's and California murres. The latter are about equal in numbers to the Pallas's or perhaps more abundant. Scattered among the murres on the larger piles of rock and on the steeper faces of the ledges are groups of red-faced cormorants. These three species make up the bulk of the population of the great Bogoslof bird colonies. There are a few pairs of kittiwakes and puffins of both kinds, a few guillemots and other birds, but murres, murres, and murres—everywhere. This is one of the largest murre assemblages in Alaska. Others comparable are on Kagamil Island in the Aleutians and Walrus Island in the Pribilofs. One could spend much time looking over the Bogoslof colony, marveling at the variation in color of the murre eggs, which vary from white to brown, and green or blue, with irregular chocolate splotchings. This spectacular bird city is one of the most memorable sights of Alaska—one hard to surpass—although there are many other colonies that possess increditable numbers of birds.

Chagulak, one of the smaller islands of the Aleutians, consists of an exceedingly precipitous volcanic cone, perhaps 1500 feet high, rising from the water as a sheer cliff, with only one or two niches where it is possible to land. Despite the almost continuous heavy surf, we landed on a little beach at the base of one of the cliffs and worked up to a considerable height. The greatest single colony of Pacific fulmars found in the Aleutians

inhabits these precipitous slopes. Pigeon guillemots, crested and paroquet auklets, and both species of puffins are also present in enormous numbers. In addition, both harlequin ducks and Pacific eiders are here, and one projecting rock several hundred feet high is closely packed with Pacific kittiwake nests. Mingled with them are a few nests of the pelagic cormorant, a species found on almost every Aleutian island.

A big rock slide on the mountain side appears to be a feasible route for reaching the fulmar nests but, long before one has climbed that far, interest forces a stop to investigate a queer chuckling coming from the rock slide itself. One sits down and remains quiet to locate the source, and eventually a little dark-bodied bird with a reddish beak and a crested head marches out from a recess in the rock, solemnly looks around, and then takes off in an air-line dive for the water. It is a crested auklet, which looks for all the world like a California quail with a red bill, except that the breast is darker and the legs shorter. This auklet's manner of carrying its head, together with the topknot, and the way it walks accentuates its resemblance to the quail. Occasionally, instead of a crested auklet, a larger, white-bellied, paroquet auklet, with its odd bill will come striding out in the same manner. The auklet performances are so intriguing that it may take some time to reach the fulmar colony.

On Chagulak it is possible to inspect closely numbers of the fulmar nests, something that is not always possible on the precipitous cliffs these birds prefer. Each nest is located under an overhanging ledge or in a crevice of the rock. The birds can be watched but it is not advisable to get too close. They allow one almost to touch them before they flush from the single white egg, but one runs the risk of being smeared with an oily substance which they can regurgitate and eject with considerable accuracy to a distance of about eighteen inches.

Neighboring Amukta Island, which can be seen across the water, is quite unlike Chagulak but equally fascinating. Amukta is an old volcanic cone projecting high enough to hold permanent snow on its summit. On the south side, there is a flat hemmed in by a great lava flow, and here is a big colony of fork-tailed petrels. The birds occupy the old lava overgrown to some extent with mosses and other vegetation. One can hear them in the crevices and the characteristic petrel smell is very noticeable. We found here also Alaska longspurs and Pacific eiders; both nest

in the meadows between the fans of the lava. European teals frequent the tiny rain-water lakes just above the beach. This duck closely resembles our green-winged teal, not only in appearance, but in flight and behavior; the lack of a white bar in front of the wing is the difference most noticeable in the field. These birds nest all through the Aleutian Islands—not in great numbers, but a pair or more to an island.

On Amukta as well as on many other islands the number of species of small land birds is limited but that of individuals may be great. Here, Alaska longspurs are very abundant, outnumbering all other small birds. Next to them in abundance are Aleutian rosy finches, followed by Aleutian song sparrows, savannah sparrows, and wrens, and Pribilof snow buntings. This is a complete list of the land birds one may expect to find on most of these islands.

It is interesting, however, to observe the variations in the relative abundance of these smaller birds. On one island, snow buntings are the most numerous; but on the next island, which looks exactly like it, the rosy finches perhaps may lead; while on a third, song sparrows or longspurs may be most abundant. One never tires of watching the big dark-colored song sparrows that stay close to the rocks just above the tide mark. They are present on every island. Their song seems almost identical with that of our much smaller and paler eastern song sparrow. It is odd to see such large birds putting out the same effort to produce no more sound than the smaller continental song sparrow. Around the Indian villages rosy finches are as familiar and as tame as are English sparrows in the states. In the western United States glimpses of breeding rosy finches are usually earned only by long walks and hard climbs in the high mountain country of the Cascades and Rockies. To one familiar with that requirement it does not seem quite right to stroll easily along the beach and see rosy finches as one of the common birds—sitting on rocks, on ridges of the Indian houses, or even on a church spire.

It would take many weeks to visit all of the principal bird colonies of the 1200-mile Aleutian Island chain. Considering a selected list of the bird cities exemplifying the various types is the only practicable treatment. Taking that course, an outline may be made of some of the problems presented by the birds, the native communities, and the fox industry, and the interrelationships among them all.

One of the most interesting bird colonies is on Kasatochi Island, whose formidable cliffs rise straight from the water. This island has a perfect crater in the top but its most fascinating feature is the enormous auklet colony. The numerous rock slides are filled with nesting birds. The most abundant species is the least auklet, which provides some of the most spectacular shows of all of the sea birds. This island and St. George, in the Pribilofs, contain least auklets in the most incredible numbers. St. George is larger and therefore probably has more birds, but no single day's observations could settle that point. On both places there are simply more birds than a person can realize in a few hours' visit. Mixed in the concentration are crested auklets, which alone are numerous enough to make a great bird colony but which are inconspicuous among the much greater numbers of least auklets. Climbing the rock slide one hears the birds chuckling and talking to themselves as they emerge from their nesting crevices. They are absurd-looking little fellows, not much larger than English sparrows, with spotted sooty and white breasts and enough scattered white bristly feathers around the eyes to give them an owl-like appearance. They stand solemnly upright on a rock and look at an intruder first with one eye and then the other.

As the auklets leave their nesting holes under the rocks, they walk out to a projecting rock and pitch off headfirst with both wings buzzing. By the time they reach the bottom of their plunge through the air, a thousand feet or more below, and flatten out to glide over the water, they are going at a phenomenal speed. An aviator might have learned power-diving by watching these experts. Certainly they have perfected the power dive to the point where they can level off only a matter of inches above the surface of the water, and shoot over it like projectiles from a gun.

As the sun sinks toward the horizon, these birds leave their nests in increasing numbers and fly out over the water in front of the great rock slides that harbor the colony. There are flocks of thousands, each a swiftly moving ribbon or patch against the sky, the birds twisting and turning in their evolutions like sandpipers. The flocks play around and over each other until the air seems awhirl with birds. Sometimes one long ribbon crosses another, both undulating as they go and alternately showing white and dark in the sun.

As it grows darker, one after another of these great flocks sweeps with a roar like a waterfall over the slides. The flocks pass

out to sea again, but hundreds of individuals drop like falling leaves to land on the rocks, some of them within a few feet of the observer. If one remains perfectly still, a great many of them, after looking over this new feature in the landscape, decide it is no more harmful than the neighboring humps of rock and go about their business. Some take off again to join one of the flocks, but many stand quietly for some time, look around, and finally disappear into their burrows.

There are other birds besides the auklets on Kasatochi—many of them—but the auklet colonies, consisting of least, crested, and paroquet auklets, with the least in by far the greatest, and the paroquet the fewest, numbers, are so fascinating as to obscure the other bird life.

To the westward of Kasatochi lies Tanaga Island, one bay of which is known to be frequented by sea otters. If luck is good, one can see on a June day perhaps twenty to twenty-five females with young which they carry around as tenderly as human mothers do their babies. Each mother otter swims on her back and holds the baby first in one arm and then in the other as she lies on the water or paddles around in the kelp beds at a safe distance from the boat.

There are no great bird colonies on the otters' side of the island but interesting small groups of nesting birds almost everywhere. It is possible to find many nests on the small rocky points projecting into the bays. One such point yielded a black oystercatcher's nest with two newly hatched young and a third egg pipped; two of glaucous-winged gulls with eggs; one of Arctic terns with eggs; and eight of eider ducks with one to eight eggs each.

Well to the westward in the Aleutians is Amchitka, one of the larger islands and home of a fine colony of sea otters. These animals, under protection throughout the Aleutian chain, are making a fine recovery from the state of almost total extermination in which they seemed doomed a few years ago. This is only one of several fine colonies and groups now known.

Amchitka is somewhat less mountainous than many of the other islands and contains numerous small lakes in the rolling tundras which dominate its surface. These tundras are the home of one of the several races of ptarmigan that have developed on the larger islands. The Aleutian sandpiper, far western cousin of the purple sandpiper and the Alaska longspur, are by far the

most abundant birds. Like all the other Aleutians, this island is covered with wild flowers.

The islands between Amchitka and Attu at the extreme western end of the chain contain many great colonies of auklets similar to those already described, as well as smaller representations of other colonial Aleutian birds.

One of the great murre colonies of the north is present on Kagamil, one of the Four Mountain group east of Atka. Here also are found an enormous number of auklets, mostly crested, although the whiskered auklet, rarest of these little sea birds, is present. The murre colony, one of the greatest of bird cities, extends for two miles or more along a gigantic cliff, every crevice and ledge of which is lined with murres. It is impossible to estimate the number of the birds, which, however, certainly runs into the hundreds of thousands. A neighboring island shelters an equally large, or larger, colony of tufted puffins, members of which can be seen coming and going in great numbers.

The outstanding bird features of the Four Mountain group are the great aggregations of California murres and the hundreds of whiskered auklets, dusky little fellows combining the characters of the Cassin's and the crested auklets. They have a white belly like the Cassin's, but a crest and dark back like the crested auklet. They behave much like the other species, flying in compact flocks that dart and twist as do flocks of sandpipers, but scattering out somewhat when feeding on the water. As a boat approaches, each bird dives, often to emerge in full flight.

St. George Island, the southernmost of the larger islands in the Pribilof group, is undoubtedly the bird metropolis of the north. During the breeding season, the water for miles about is covered with birds and the air is filled with them. From the village on St. George Island, one looking at the swarming myriads is convinced that he is viewing the greatest numbers of birds that can be seen at one time.

Behind the village of St. George there is an old volcanic ridge, honey-combed with crevices and holes, that for several miles forms the backbone of the island, and it seems to be literally full of nesting least and crested auklets. Seen from the village, their numbers in the air are comparable only to those of the enormous swarms of blackbirds that are sometimes observed in the Mississippi Valley and on the Gulf coast. At a single glance one sees not one, but a dozen, vast swarms coming and going from the

feeding grounds. Along the summit of the ridge they swirl like bees around a hive. As far as the eye can reach the water is covered, and the air above filled, with auklets.

St. George Island is also the home of the beautiful red-legged kittiwakes. A huge concentration nests each year on steep cliffs at the north end of the island, about five miles from the village; smaller colonies are found on St. Paul Island, which lies about forty miles to the north. Every species of sea bird native to the region seems to be on St. George. Paroquet auklets are there in numbers, although limited when compared with the others. There are also Pacific kittiwakes, glaucous-winged gulls, red-faced cormorants, Pallas's murres, pigeon guillemots, Pribilof sandpipers, both species of puffins (although neither is very abundant), and long-tailed jaegers.

If one were to choose a single place to see a great bird colony, St. George, because of the number of birds present and the ease with which they may be observed, would be first choice. With its Pribilof sandpipers and its many sea birds, rarely seen by most ornithologists, and with Aleutian rosy finches and Pribilof snow buntings as common dooryard birds, St. George is a first-class ornithological observatory—a paradise for the most exacting student.

A few miles off St. Paul lies Walrus Island, a flat-topped rock of about seventy-five or eighty acres just above ordinary storm tides. As one approaches, this rock seems to be covered with birds. About twenty-five acres in the center are occupied by glaucous-winged gulls and smaller numbers of glaucous gulls. The remainder of the island is a solid mass of murres—Pallas's in the majority. An estimate of the numbers of this great mass of birds —basing it on egg counts per square rod or any other method— soon begins to run into the millions and one gives up in despair. Each bird, sitting soberly upright with a single egg between its feet, represents only half of the family; the other half is among those that cover acres of water round about. Scattered over this island are rocky pinnacles, each of which supports one or more cormorant nests. The faces of the low cliffs of Walrus Island are occupied by Pacific kittiwakes and murres, which nest on the ledges and in the crevices, as well as on top of the island. Among them are a few horned and tufted puffins and a very considerable number of paroquet auklets. But it is the murre and gull concentrations that dominate the bird rookeries. On one end of the

island there is a big sea-lion colony, which frequents the rocks just above the wash of the tide.

St. Matthew Island, more than 200 miles farther north, was originally set aside as a fox-breeding area on the basis of reports that indicated the presence there of Arctic foxes. St. Matthew, together with its companion, Hall Island, comprises the Bering Refuge. The most impressive wildlife feature is a Pacific fulmar colony that extends almost without a break for something like five miles along the cliffs on the south end of the island. Paroquet auklets also are exceedingly abundant; in fact, the farther north one goes the more common this species becomes. Horned puffins are numerous, but only a few tufted puffins live on St. Matthew. Pelagic cormorants are the only birds of their genus present. The enormous sea-bird colony alone is sufficient justification for maintaining St. Matthew as a refuge. It has the largest Pacific fulmar concentration on any federal reservation. Both Superintendent Gray, of the Aleutian Refuge, and Captain Sellevold, of the *Brown Bear,* Aleutian Island patrol boat, say that this fulmar colony is larger than any in the Aleutians. In addition to the birds already mentioned, there are numbers of Pallas's murres and a good population of three species of ducks, namely the harlequin, Pacific eider, and old-squaw. There is also a fair breeding representation of northern phalaropes, and Pribilof sandpipers are just as abundant here as on the Pribilofs.

Last but not least among the common birds is McKay's snow bunting. To see it is worth a trip to St. Matthew to any ornithologist. It is a beautiful species, pure white except for a little black on the wings and tail that is not readily visible as the bird sits on the rocks or snowbanks. This snowflake proved to be common, and we saw hundreds, from newly fledged young to clear white old males and the less attractive females. Alaska longspurs also were common. A big meadow on the north end of the island is the home of little brown cranes and long-tailed jaegers.

The most interesting thing on this island is the unique McKay's snow bunting, and second the enormous bird city around the great cliffs at the southern end. This is one of the most spectacular colonies in Alaskan waters, but making special note of it does not imply that there are few or no birds on other parts of the island. On the contrary, any part of the shore of St. Matthew has its quota of communities of sea birds. Puffins,

PLATE 9

MANY JOBS MUST BE DONE TO CREATE A NEW WILDLIFE HABITAT

Upper. Clearing land which is to be flooded. Upper Souris Wildlife Refuge.
Fish and Wildlife Service photograph by Leo McMinn

Lower. Artificial shelters and food are provided until natural food and cover can be grown. Many refuges have been made on overgrazed or otherwise badly abused lands.

Fish and Wildlife Service photograph by B. M. Hazeltine, Bowdoin National Wildlife Refuge

PLATE 10

CLOSE-UP SHOTS OF SOME INHABITANTS OF THE ALASKAN BIRD CITIES

Upper left. The high-cut waistcoats of the Pallas's murres are conspicuous.
Fish and Wildlife Service photograph by J. H. Steenis, Bogoslof Island

Upper right. A red-faced cormorant looks over an intruder.
Fish and Wildlife Service photograph by J. Malcolm Greany, Adokt Island

Lower left. Cormorants set on their nests like long-necked black chickens.
Fish and Wildlife Service photograph by J. Malcolm Greany, Aleutian Islands

Lower right. Aleutian sandpipers breed throughout this twelve-hundred mile Aleutian refuge, and gather in flocks when the young are on the wing.
Fish and Wildlife Service photograph by J. Malcolm Greany, False Pass

murres, glaucous gulls, Pacific kittiwakes, guillemots, and harlequin ducks are everywhere.

The same thing is true of Hall Island, the southern and western sides of which are sheer cliffs, and only on the north side is it feasible to land. This is a much smaller island than St. Matthew and is separated by three or four miles of strait with swift, tidal currents.

These great concentrations of bird life impress a visitor with the fact that Alaskan waters are a paradise for seafowl. One wonders about the enormous amount of food required to keep such numbers of birds for a single day; the seas must teem with it.The natives eat a great many of the birds and their eggs, but the number they take is so small in comparison to the total that it makes no impression.

Some of the colonies of certain types of birds in the Aleutians, however, have been all but exterminated by foxes. Some of the so-called fox farms have been abandoned, but considerable numbers still exist and the foxes on some of the islands are still making inroads on the nesting birds. Under the present administrative policy, these more valuable breeding islands will be taken out of fox production and the industry restricted to the larger islands, where, moreover, there is more chance for its success. The smaller islands do not have beach line enough to furnish the food on which the foxes largely subsist when it is available, and consequently the animals must eat the birds or starve.

It is unfortunate that so few people can see the vast colonies of birds, as well as the seals and sea lions, and realize the wealth of wildlife that the Alaskan seas and islands and coasts support, a living zoölogical museum that is as yet practically untouched. It is possible for it to remain so. The major bird colonies are protected and have as much patrolling as present circumstances permit. This patrol can be intensified if conditions demand, and additional colonies can be made refuges if the need arises. In the meantime, it is cheering to know that protective measures have been taken in ample time to save some of the most spectacular concentrations of wildlife now existing in North America.

CHAPTER VI

Special Refuges

Scattered along both coasts of continental United States, and in a few inland localities, there are numerous small island refuges set aside for the protection of colony-nesting birds. The most numerous groups of these are in Oregon, Washington, and Florida. There are additional island refuges in the Hawaiian group and in Alaska. The latter have been discussed in a previous chapter, and so are not further treated.

The *Great White Heron Refuge,* consisting of a number of small islands and parts of islands lying about sixty miles off the tip of Florida eastward of Key West, together with the Key West Refuge, a similar group to the westward of that city, is one of the largest of the special refuges. As its name indicates, this refuge was established primarily to protect the great white heron —largest and most majestic species of its tribe on this continent. The nesting sites are on mangrove islands that thickly dot the pale green waters of the Gulf of Mexico. The mangroves are not tall but are of an exasperating size which permits the birds to place their nests too high to be peered into from slippery perches on the arching roots that stand well above the muddy bottom. Only occasionally is one of the trees robust enough to climb. Mosquitoes are abundant and usually eager to bite and, with the slim wicket-like mangrove roots, make a tough combination to fight in endeavoring to explore the islands for bird-census or observation purposes. The "conchs," or native beach combers, who have often raided the rookeries to get young herons to eat had no desire to see into the nests but effectively used long poles to dislodge the nestlings from their platforms of sticks.

Visitors, of whom there have been many in recent years, desiring only to see and study the stately adult birds have no difficulty in so doing. The herons' size and pure white plumage render them conspicuous amid the dark green of the mangroves. Together with other herons, they are to be found in straggling companies on bars and shoals or silhouetted against the sky atop the man-

grove thickets. This maze of islands and shallow waters seems ideal heron country. Except for the deeper channels used by the patrol boat or an occasional fishing craft, there are few places in which these big herons cannot wade. To see one flap along over a wide space of water, suddenly let down its landing gear, and alight to all appearances in the open gulf is a bit startling. One soon gets accustomed to the conditions, however, and the sight of herons scattered over open water whenever the boat emerges from behind one of the innumerable mangrove keys becomes the accepted thing.

This area, first guarded by the National Audubon Society patrol and later, after being made a national refuge, by wardens of the Fish and Wildlife Service, protects many other birds besides the great white heron. Second in interest only to the great whites are both Ward's herons, the local subspecies of the familiar great blue heron and Würdemann's herons—once thought to be a distinct species, but now recognized as hybrids between Ward's and the great white.

The mangrove islands also shelter the only nesting pairs of the beautiful white-crowned pigeon, to be found on any national refuge.

In winter, man-o'-war birds are common and may be seen circling in effortless flight over their roosting places. Terns, gulls, kingfishers, and herons, with an occasional osprey, perch upon every channel marker or old piling along the water routes. The birds seem to know that no harm will come to them and often allow a boat to pass within a few feet without moving.

Maynard's cuckoo, the gray kingbird, and the Key West and black-whiskered vireos are among West Indian forms that visitors have a chance to see. In addition, there are various migrants from the North that use these keys as a take-off for Cuba and other points south.

In addition to the Great White Heron Refuge, numerous islands in Florida coastal waters comprise the largest grouping of refuges of this class in any part of the country. Colonies of water birds, such as brown pelicans, cormorants, and numerous members of the heron family, are protected by these refuges. Unfortunately the birds often desert a nesting area, and an island reserved for their use may be unoccupied for several years. Nevertheless, the policy is followed of retaining the islands in order to preserve suitable nesting habitat for these birds of rather spe-

cialized needs. Recolonization of several islands some years subsequent to abandonment seems to furnish abundant justification for this policy. These islands also help to maintain natural feeding grounds, and roosting places for these picturesque birds that are such an important part of Florida scenery.

Pelican Island, the first national wildlife refuge, has been little used recently by the great brown pelicans for whose protection it was established, but it has been the home of a thriving mixed colony, including the white ibis, and black-crowned night, little blue, Louisiana, and great blue herons, and snowy and American egrets.

In the meantime, *Brevard Island,* a few miles to the north, has been the home of the pelicans, and eggs and young may usually be found for at least nine months in a year. In former, and less frequently in recent, years fishermen have been accustomed to raise a great outcry over the alleged destruction of valuable fishes by the birds of these colonies. Studies of the birds' food habits have failed to sustain the accusations, as they have revealed that a large proportion of useless or low-value fishes are taken. During the past few years an increasing number of white pelicans have been associating with their smaller brown relatives on this refuge and some are reported to have nested there in the spring of 1941. Brevard also harbors a fine mixed colony of herons and provides wintering grounds for various northern birds.

The west-coast islands are more numerous and at present more important as refuges. They lie in three groups in and about Charlotte Harbor, Tampa Bay, and the mouth of the Suwannee river, a stream that originates on the Okefenokee Refuge in southern Georgia. Thus this river, famed in song, draws its waters from one refuge and discharges them into the Gulf about the shores of the numerous islets that comprise the Cedar Keys Refuge.

During the past several years *Passage Key,* with its prosperous colonies of laughing gulls, royal terns, and black skimmers, and *Indian Key* with its mixed colonies have been important and are quite typical of the Florida west-coast refuges. Both are in the Tampa Bay group, and like the other island refuges are patrolled by an itinerant warden. He is equipped with a car and trailer on which a light skiff and outboard motor are carried. Traveling up and down the coast on an irregular schedule he is able, with the help of watchful residents interested in these refuges, to maintain

a fairly adequate patrol. His 1941 reports estimate that the Passage Key colonies contained 2500 pairs of laughing gulls and 500 pairs of black skimmers. Royal terns were last reported nesting in numbers on this island in 1938.

The reports for Indian Key for the same season estimate 350 pairs of brown pelicans, 2000 pairs of Florida cormorants, 200 Ward's herons, 200 American egrets, 50 snowy egrets, 50 Louisiana herons, 50 little blue herons, and 500 white ibises. There were numerous other birds present, the largest group being a flock of some 5000 man-o'-war birds; these do not breed in the United States but roost here during the breeding season of the other species.

The rare roseate spoonbill is seen occasionally on some of these refuges. Indian Key is the National Refuge most often used by this bird now nearly extirpated from Florida. They do not nest here, although a few were reported as nesting on a nearby island in 1939, but do appear periodically in spring and early summer. As many as 200 have been counted in one day but the usual number reported varies from 25 to 60. This island is a favorite spot with local bird enthusiasts, who guard it jealously—as well they may, for it contains enough of interest to fascinate any ornithologist.

Farther west, along the Louisiana coast, is another cluster of little islands harboring colonies of brown pelicans, laughing gulls, and Cabot's, royal, Forster's, least, and Caspian terns, and black skimmers. By far the most important of these refuges is the *Breton Island* group off the Mississippi Delta. It is the summer home of larger tern and skimmer colonies; in addition, the refuge provides food in its sheltered shallows for large wintering populations of black ducks, baldpates, pintails, scaups, golden-eyes and, most important of all, redheads, the last-named a species much in need of protection. Numerous species of shorebirds also winter here while others stop on their migrations.

Diagonally across the continent in Puget Sound and along the Oregon and Washington coasts, numerous small rocky islets furnish breeding grounds for a wide variety of seafowl. Such interesting birds as California murres, tufted puffins, rhinoceros and Cassin's auklets, pigeon guillemots, western gulls, glaucous-winged gulls, fork-tailed and Beal's petrels, Baird's, Brandt's and Farallon cormorants, and black oyster-catchers frequent these rocky pinnacles. Many of these refuges are rocks whittled down

by the sea from mountain ridges that project into the water. Many are almost unscalable "haystacks" or "arch" rocks, the latter as the name implies being pierced at the base by the ceaseless pounding of the hurrying waters.

Three Arch Rocks are among the most populous of these colonies and certainly the best known. They were first made known to the world and became a refuge through the writings and work of William L. Finley, one of the pioneer crusading conservationists responsible for awakening the American public to the value of wildlife. This refuge consists of three rocks, each in the form of a huge arch. Stanley G. Jewett's notes, made on a visit in 1913, are of interest in comparison with those in 1940. Fork-tailed petrels were abundant on the first trip; none were found on the second. Beal's petrels were found on both occasions but no estimates of numbers were made. The populations of Baird's and Brandt's cormorants remained about the same. Jewett found three pairs of oyster-catchers in 1913 and only one in 1940. Western gulls decreased materially between the two visits and tufted puffins, estimated at 10,000 pairs in 1913, were reduced to 10 pairs in 1940. On the other hand, California murres were estimated at 750,000 as compared with 500,000 on the earlier visit. The decrease in some forms is regrettable and, it is to be hoped, will not prove permanent. In any event Three Arch Rocks is one of the great bird cities of the continent, one of the few in the United States that can even remotely compare with those of the Bering Sea.

The *Farallon* group, lying off the mouth of San Francisco Bay, furnishes homes to similar colonies of seafowl. This refuge, comprising ninety acres of rocky islands, is the home of puffins, auklets, guillemots, murres, and petrels. These islands have been visited periodically by California ornithologists for many years and their published records, together with the somewhat scanty additional information in the files of the Fish and Wildlife Service indicate remarkable shifts in the bird population. In 1887 the ashy petrel was reported as a rare breeding species. By 1903 it had become fairly common and in 1911 it appeared to be the second most abundant breeder. In early days the Farallon cormorant was abundant, later it decreased almost to the vanishing point, but in 1933 (date of the last report) had increased somewhat again. Brandt's cormorant, while decreasing somewhat, recovered more quickly and has remained the more abundant of

FIG. 1. Special refuges administered by the Fish and Wildlife Service on March 1, 1942. These refuges are chiefly valuable in protecting nesting colonies of nongame birds.

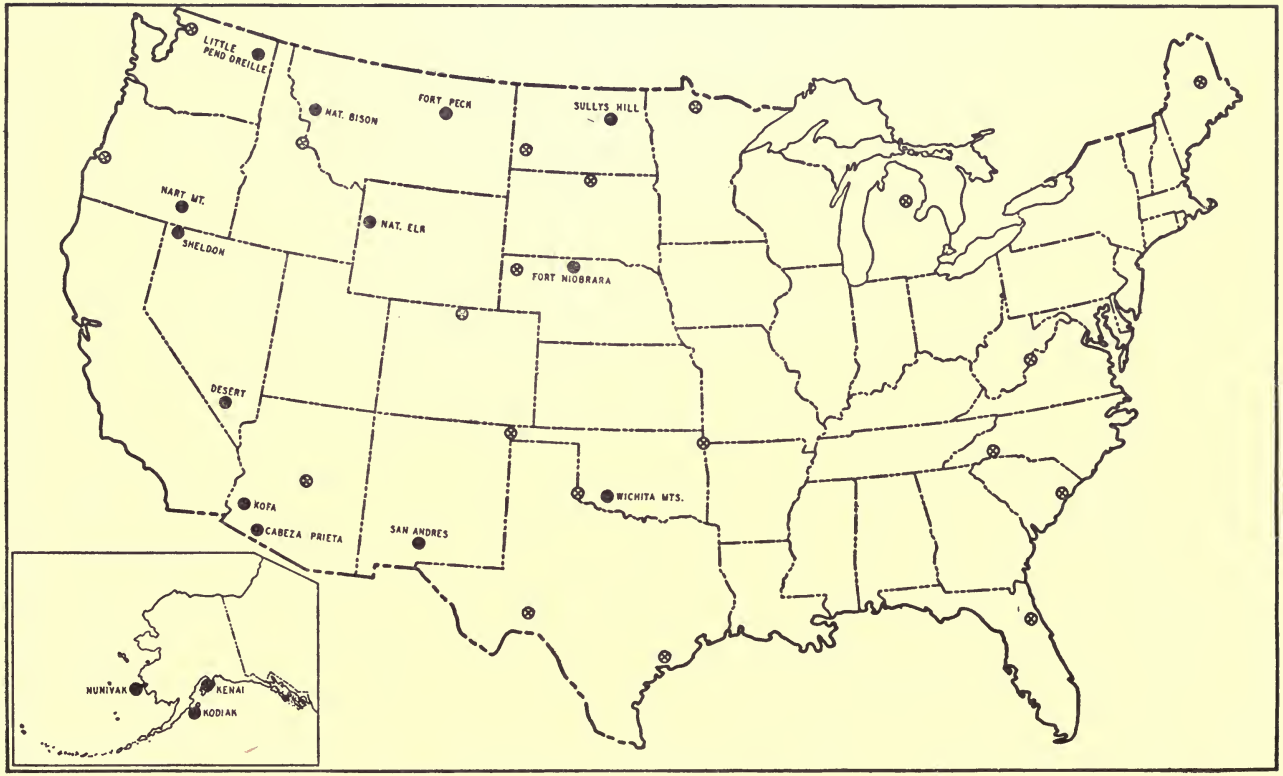

FIG. 2. Big game refuges administered by the Fish and Wildlife Service on March 1, 1942. Crossed circles represent areas in which refuges are still needed to complete an ideal system of big game refuges.

the two species. Western gulls now occupy much of the space formerly used by California murres, which once outnumbered all other water birds combined, but decreased until only a few pairs remained in 1933. Waste oil, gull depredations, and disturbances by man are supposed to be the cause of the decrease and finally almost complete elimination of this once-abundant species. The tufted puffin, once outnumbered only by the murres, has also greatly decreased and the colony in recent years has been limited to a few hundred pairs.

The extent to which other types of refuge have been utilized by the colony-nesting water birds is shown graphically by a review of the 1941 reports. Newly flooded lands, whether on big-game or waterfowl refuges, quickly attract these birds. White pelicans are now known to be nesting on 12 refuges, brown pelicans on 14, double-crested cororman ts on 30, great white herons on 2, great blue herons on 31, American egrets on 23, snowy egrets on 22, Louisiana herons on 19, little blue herons on 15, green herons on 19, black-crowned night herons on 34, American bitterns on 34, white-faced glossy ibises on 5, California gulls on 12, ring-billed gulls on 14, Franklin's gulls on 10, Forster's terns on 22, common terns on 27, least terns on 16, and black terns on 32.

A few scattered small islands and points in the interior lakes afford protection to colonies of such birds as white pelicans, Caspian terns, common terns, herring gulls, and double-crested cormorants. These island refuges, important at the time of establishment because of the scarcity of the species they were to protect, have declined in value in recent years. Many of the marshes reflooded in the waterfowl restoration program of the past ten years contain islands which have been promptly populated by thriving colonies of the same species. They furnish equally acceptable nesting sites and often better and more extensive feeding grounds. As a consequence some of the smaller inland refuge units have been entirely abandoned by the birds and perhaps as time passes others will outlive their present limited usefulness. So long as the birds use them, however, their value as local conservation object lessons and the interest they have for local bird students are reasons enough for their retention as refuges.

CHAPTER VII

The Fur-Seal Islands

Since the Russians, grouping their way through the stormy, fogbound waters of Bering Sea looking for the home of the fur seals, first came upon the group of small islands known to us as the Pribilofs, these tiny dots of land have held much of interest to biologists.

Kipling wrote of battles over the fabulous wealth of fur seals, and perhaps sea otters as well, between the hard-bitten crews of Russian, Japanese and American vessels during the days of pelagic sealing. The seal herd seemed inexhaustible; it was a case, as is too often true, of the abuse of a natural resource on the principle of first come, first served. For many years the bloody and wasteful slaughter of the seals went on, first under Russian, and then for two years under American rule. Various government bureaus and organizations had a hand in administering a resource that continued steadily downward until it no longer supported a profitable business for pelagic sealers or the commercial company which had the last concession.

There seems to be no point in going further into the gory details. It would be merely a duplication of the tragic story of a hundred other resources that the people of America once ravaged but in recent years have been trying to rebuild. Forest, grassland, marshland, wildlife—yes, even the soil, most precious of all natural assets, have alike deteriorated because of senseless exploitation by greedy and avaricious men.

Rather than talk about the ravishment of the Pribilofs, it seems infinitely better to devote the available space to recounting one of the most spectacular and successful wildlife restoration projects in history. The story begins in 1911, the date of the fur-seal convention between Russia, Japan, Great Britain, and the United States. Under its terms all pelagic sealing was stopped and management of the Pribilof seals was vested in the United States. Japan was to manage herds on Robbin Island and Russia those on the Commander Islands. There were many provisions

in these treaties but, except for these mentioned, only one was of major importance. In any harvest taken from the Pribilof herds, Japan and Canada were to share to the extent of 15 per cent each. Russia received no share but retained the privilege of managing her own herd.

Starting with this treaty and the enabling act which made it effective, the administration of the islands, including the care of natives and the management of the seals, was made a responsibility of the Bureau of Fisheries. In 1910 the once innumerable seals had been reduced to a remnant of 130,000 animals. Under strict protection for years and good management thereafter the herd rapidly recovered. In 1941 an estimate based on the number of bulls, the average size of the harems, and other factors, indicated a herd of 2,338,312 animals.

The Pribilof Islands constitute a special reservation and are not administered as a part of the national wildlife refuge system. Separate administration is advisable because of historical reasons and because of the complicated task of protecting and harvesting the seals and caring for the natives.

Fascinating days can be spent on the seal islands, every day all too short from the naturalist's point of view, despite the fact that darkness is only relative at any time in summer and daylight is almost continuous. These five small islands, only two of which, St. Paul and St. George, are inhabited or habitable, would be of great interest even without the great herds of fur seals. These are merely the crowning spectacle of an otherwise extraordinary biological display. The gigantic bird cities here have been discussed briefly in the chapter on the bird cities of Alaska. These colonies rival, if they do not exceed in size, any others of this continent and its satellite islands, including many areas to which ornithologists gladly make pilgrimages. The most populous Atlantic coast bird rookeries would be lost among the swarming millions of birds on St. George Island. Gulls, kittiwakes, puffins, cormorants, murres, and above all auklets, swarm along the shores and over the adjacent waters. Land birds are few in species but rather numerous. Snow buntings and rosy finches are the most common, while longspurs and Pribilof sandpipers are also present in numbers. The tiny Alaskan wren, a replica of the continental winter wren, whose Aleut name means "chew of tobacco," is found only on St. George Island, where a number of individuals usually can be seen along the rocky shore line.

In this region of constant gales, there are of course no upright woody plants. The tiny willows, cranberries, and other woody forms creep on the ground in spongy mats difficult to walk through. The vegetation is like that above timberline in the higher continental ranges. Many alpine plants and the rosy finches that frequent the stormy and forbidding mountain peaks farther south are abundant here on level ground and it does not seem quite fitting to step out of a boat and wander over "alpine" meadows on the flats. The rosy finches greet the visitor at the shore and, perching on the rocks, buildings, and light wire of the village, are acceptable substitutes for the English sparrow bands found in settlements of the southern mainland. White-plumaged snow buntings flit over the flower-decked slopes like huge white butterflies. These birds, when visiting the states, are usually associated with cold and snowy landscapes. Yet here they live among blue lupines, yellow Arctic poppies, pink elephant heads, blue violets, and forget-me-nots, the pale yellows and whites of some of the mat-forming saxifrages, and most unbelievable of all sky-blue, foot-wide mats of *Eritrichium,* most breath-taking of all American alpines. Many enthusiasts have scaled high and difficult rocky peaks to see this alpine aristocrat in far less perfect form than here spread out for easy view. The celestial blue of the myriad blossoms against the silvery background of closely packed leaves is as clear and perfect as on any mountain height, despite a half-formed and perhaps never admitted belief that part of the appeal of this little forget-me-not in the United States is its obvious liking for the most forbidding and inaccessible habitats.

Much could be written of the birds and flowers of the Pribilofs, and of the sea lions and blue foxes, both of which are a conspicuous part of the fauna, but the supreme attraction lies in the herds of over two million fur seals—the most valuable group of fur animals in the world.

Each of the two main islands has numerous rookeries—great seal cities on the rocky beaches, where the drama of life never stops while the seals are there. Some of the larger colonies number as many as 200,000 animals. To these cities, deserted in the winter months, the old breeding bulls return in May or early June. Here, after much maneuvering and fighting, those individuals strong enough to hold and guard an area await the return of the females. As the females haul out on the beaches, heavy with their unborn pups, each male seeks to get as many as possible

in his harem. Many harems at the height of the breeding season contain from forty to sixty females; an occasional male will manage to collect a hundred or more wives. Next door there may be a male with only one mate, and on the beaches the "idle" bulls that have not been able to win a place in the front line take up stations and are ready to capture the affections of any female that may by chance leave the harems or to steal a wife from the harem when the master's back is turned.

With one wife or a hundred, the old bulls enter a life of ceaseless activity, during which they never leave the rookery to eat. During this same period, they never have an opportunity to sleep with more than one eye shut. Around and around the harem they travel, fighting off the raids of envious bulls, keeping an eye on human intruders, and preventing the cows from straying for they, too, are not permitted to leave until their pups are born and they are again bred, after which they make long excursions to sea for food, returning at intervals to nurse the pups.

Such continuous activity among large animals seems strange. The great herds of game animals stop to eat, sleep, and rest, but here life goes on with a twenty-four hour day and a seven-day week schedule. Birth and death, breeding, living, fighting—the drama is continuous. If the observer fastens his attention on one harem it is certain that he will miss something of great interest in some part of the herd. It is as impossible to see everything here as it is in a three-ringed circus. One can spend hours watching the seals.

All activity centers around the family life of the harem and all males of breeding age are interested. The bulls that have been successful in collecting one or more wives put in full time on guard to keep from losing them. Those still unsuccessful put in equally lengthy hours trying either to get an unattached female or to steal one from the family of some more fortunate bull. Each harem master has a dead line over which no other bull is allowed to pass without a fight. Nevertheless the more reckless bulls do frequently cross the line and a dozen brief but sometimes bloody battles may be going on simultaneously, and it is no uncommon sight to see males with numerous gaping wounds from these encounters. Frequently the females show similar deep gashes about the head and neck as a result of stern discipline meted out to them for flirting with the neighbors. A female may attempt to get back into the water or to join the handsome gentleman next door. She

usually tries to slip away while the head of the house is on the opposite side of the establishment. She knows that if she can once cross the other fellow's dead line she may get away. The "head man" knows it too. Once she reaches the alien territory he must choose between losing her or invading the neighboring harem to recapture her by force. This means battle during which "good neighbors" may make off with several others of his wives. Knowing all this he takes prompt and decisive action at the first move the flirtatious lady makes. If his warning note goes unheeded, he dashes straight through his family, knocking pups and wives in all directions. The offending wife is seized, shaken vigorously and often sent sailing over his head back into the harem, with bloody gashes in her sleek fur. One such lesson is usually sufficient to make her a model wife.

As the season advances the black pups become more numerous, playing about the rocks in little bands but sticking close to their own homes at first. Later they roam the rookeries like street arabs.

As the later arriving cows haul out on the beaches, the rookeries become so crowded that a human observer is at a loss to distinguish between families, though the old bulls loom up so much larger that it is comparatively easy to count the number of harems on any given section of the beach. Through July and well into August the rookery life runs at a feverish tempo. At a distance the voice of the seal city sounds like the roar of heavy surf. Nearby it resembles the baaing of an enormous band of sheep over which one still hears the hoarse barking of the old bulls.

The males do not enter the breeding herd until they are six or seven years of age, while the cows come in at two. The males between two and six years of age haul out on grounds adjacent to the rookeries and keep bachelor quarters while developing the size, age, and strength necessary to participate in the harem life.

Upon the presence of excess males is based the present management of the herd. The practice is to select a certain percentage of the three-year-old males for slaughter to provide a supply of seal-skin coats. This seal harvest, carried on under rigid control, is the best managed wildlife cropping that exists today.

Fur seals and the life of the inhabitants of these two remote islands of St. George and St. Paul are inextricably entangled. Human livelihood, customs, and thinking revolve around these great herds of fur animals. In the past twenty-six years the Bureau

of Fisheries, and the present Fish and Wildlife Service, in coöperation with the Fouke Fur Company and its predecessor, have gradually perfected the system of handling the harvesting and developed new techniques for caring for the skins. The local inhabitants—a mixture of Russians, Aleuts, and occasionally other races—furnish the trained crews that carry out the driving, sorting, killing, and skinning of the animals. Much of the work of processing the skins is also performed by these people.

In regular rotation, on fixed schedules, each hauling ground is visited by the crews. The men rush quickly along the shore between the seals and the water. Once that is accomplished the animals can readily be driven back onto the flat tundra. Here a few boys or men can hold the entire company. Other workmen cut out small groups of animals, which are driven some distance away to be killed and skinned. Those rejected are allowed to go back to the sea. The selected animals are stunned by a blow from a heavy stick and skinned with no more confusion than would be found in the best organized abattoirs in the states. The drives start about 3 A.M. and in four or five hours the driving, skinning and handling of 2000 or more animals will have been completed. On St. Paul all carcasses are made into seal meal and oil at a reduction plant. On St. George the herds are too small to make similar operations feasible. The natives on both islands regularly eat seal meat, and seal livers are occasionally served at the mess for visitors. It is not bad tasting, being much like calves' liver, except for a slight flavor of seal oil.

During the years the seal herd has been under this type of management, it has grown to its present enormous number. Examination of the old rookeries, however, reveals that at some time in the past they were even larger than those now occupied. Perhaps twice as many animals can eventually live here, but sooner or later, if the present policy is continued, the herds will reach maximum size and management designed to hold the numbers at a required level. Studies are already under way to determine how best that may be accomplished.

During the time this herd has been managed it has brought increasing returns. The following table will show how the numbers have built up over the years despite a slowly growing harvest of skins. The number of skins taken has gone rather consistently upward while the amount of money received has fluctuated according to economic conditions and the vagaries of fashion.

PRIBILOF ISLANDS FUR-SEAL INDUSTRY UNDER GOVERNMENT MANAGEMENT

Calendar Year	Animals in Herd	Number of Skins Taken	Number of Skins Sold	Gross Amount
1910	132,279	12,964	[1]12,920	$ 435,532.69
1911	123,600	12,138	[1]12,002	416,949.62
1912	215,738	3,191	...	...
1913	268,305	2,406	[2] 5,669	195,868.58
1914	294,687	2,735	...	...
1915	363,872	3,947	...	...
1916	417,281	6,468	1,900	74,530.00
1917	468,692	8,170	6,739	269,665.50
1918	496,432	34,890	8,100	375,385.00
1919	524,235	27,821	19,188	1,504,083.50
1920	552,718	26,648	14,852	1,707,071.00
1921	581,443	23,681	31,002	1,050,722.16
1922	604,962	31,156	30,177	924,532.05
1923	653,008	15,920	20,866	632,422.10
1924	697,158	17,219	37,110	999,187.54
1925	723,050	19,860	17,350	565,253.82
1926	761,281	22,131	23,371	761,102.11
1927	808,870	24,942	23,618	775,899.18
1928	871,513	31,099	23,687	808,509.97
1929	971,527	40,068	29,346	823,855.36
1930	1,045,101	42,500	34,475	689,291.73
1931	1,127,082	49,524	45,982	897,196.16
1932	1,219,961	49,336	33,996	403,461.08
1933	1,318,568	54,550	50,587	873,643.22
1934	1,430,418	53,470	50,753	986,699.55
1935	1,550,913	57,296	53,422	1,246,058.85
1936	1,689,743	52,446	43,410	1,222,315.18
1937	1,839,119	55,180	42,968	1,111,039.61
1938	1,872,438	58,364	45,231	964,157.68
1939	2,020,774	60,473	43,071	823,885.90
1940	2,185,136	65,263	60,293	1,247,230.62
1941	2,338,312	95,013	62,788	2,343,319.11

[1] Sold in raw-salted condition by C. M. Lampson & Co., Selling Agents, London, England.

[2] Sold in raw-salted condition; 3,773 sold by C. M. Lampson & Co., London; 1896 sold at St. Louis, Missouri.

Not only has the seal herd been steadily increased by the management described but at the same time it has furnished a livelihood to the inhabitants of these lonely islands. The government is obliged to feed and clothe, and furnish medical attention and school facilities for these people. To carry out this obligation the Fish and Wildlife Service motorship *Penguin* makes five trips each year from Seattle to the islands carrying food and supplies northward and hauling seal skins, oil and meal southward. In recent years this has been a growing business profitable to the

PLATE 11

THE GREAT BIRD CITIES OF ALASKA ARE GREAT BIOLOGICAL SPECTACLES

Upper. Glaucous-winged gulls await a chance to rob a murre colony.
Fish and Wildlife Service photograph by J. Malcolm Greany

Center. Crested auklets and least auklet (one bird) form populous bird cities.
Fish and Wildlife Service photograph by H. Douglas Gray, Aleutian Islands

Lower left. The ancient murrelet is often overlooked.
Fish and Wildlife Service photograph by J. Malcolm Greany, False Pass

Lower right. California and Pallas's murres on Bogoslof.
Fish and Wildlife Service photograph by Ira N. Gabrielson

PLATE 12

COLONY-NESTING BIRDS OFTEN MOVE TO REFUGES WHEN SUITABLE HABITATS ARE CREATED

Upper left. Reddish egrets at Aransas National Wildlife Refuge. This is one of the few federal refuges on which this rare bird can be seen.

Fish and Wildlife Service photograph by J. O. Stevenson

Upper right. Roseate spoonbills and snowy egrets on Texas islands protected by the National Audubon Society.

National Audubon Society photograph by Allan D. Cruickshank

Lower left. The whooping cranes, one of the near-vanished Americans, find winter sanctuary at Aransas.

Fish and Wildlife Service photograph by W. F. Kubichek

Lower right. Red-faced cormorants prefer the steep cliffs of the rocky islands that dot Bering Sea.

Fish and Wildlife Service photograph by J. Malcolm Greany, Adokt Island

United States and the other treaty nations. In other words, here is a natural resource placed under intelligent management which, over a long period of years, has recovered sufficiently from previous abuse to furnish a living to the local community dependent upon it and to yield a growing profit to the nation as a whole. We have assured an increasing number of seal-skin coats for the ladies and a profitable business enterprise in one operation.

Now seal management is threatened by abrogation of the treaty by Japan, which became effective October 24, 1941. War followed so quickly that no pelagic sealing could be developed so that as yet this valuable asset remains unharmed.

We should keep it so and at the end of the war one of our aims should be to see that not only is the seal herd maintained at its present numbers and value but that it be given opportunity to expand to its highest productivity so long as it does not prove destructive to other interests.

CHAPTER VIII

Big-Game Refuges

Big-game refuges, although few in number, occupy an important place in the national wildlife refuge plan. They furnish safety for the big-game animals and preserve suitable environment for them and for many other birds and mammals. Thus, they contribute directly to the major objective of providing natural homes for every wildlife species somewhere in this refuge system.

Not all of the big game protected by the Fish and Wildlife Service is found on the big-game refuges. On the contrary, it finds sanctuary on many of the general wildlife, and the migratory waterfowl, refuges. Lands specifically included in the big-game category of refuges are ranges set aside to protect special herds of animals. In the United States, three are devoted to the bison, one to elk, three to antelope, four to mountain sheep, and in Alaska one each is for the brown bear and the moose. Most forms of white-tailed and mule deer and the black bear are already partially provided for by other refuges, but there are still a few species for which refuges are needed large enough to preserve a good sample of both the animals and their special environments. Either big-game, or general wildlife, refuges of suitable type and size might meet the requirement. At present no national wildlife refuge adequately protects the moose, caribou, mountain goat, or grizzly bear.

BISON RANGES

Four areas now in the national wildlife refuge system contain bison. Three of these have herds totaling 1081 animals, while the small Sullys Hill Refuge in North Dakota has an exhibit of sixteen animals.

The National Bison Range, set aside in 1908 as a direct result of the crusade then being waged by conservation groups, was the first refuge established by Congress under the jurisdiction of the Biological Survey. The American Bison Society, organized

in 1905 to work for the preservation of the American buffalo, led the fight for a Congressional appropriation of $40,000 for purchasing the land and fencing it, and then raised by private subscription $10,560 to purchase animals. By purchase and gift the association furnished forty head to stock the area. The animals have prospered and there are now 435 animals on the range. It is necessary to hold the total stocking somewhere below 500 to insure perpetuation of the range, which was badly overgrazed during the drought years. On May 17, 1933, a white male calf was born, an event which excited much interest because of the rarity of albinism among the bison. It was promptly named "Big Medicine" and grew into a fine healthy animal.

The National Bison Range consists of 18,541 acres of rather rough country, partially wooded on some slopes, but consisting largely of open grasslands. It is entirely surrounded by a big-game fence and protects, in addition to the bison, small numbers of elk, deer, and mountain sheep.

In 1919 Martin S. Garretson, then secretary of the American Bison Society, visited the range. His report to the Society at its annual meeting in New York on January 8, 1920 expresses satisfaction with the management of the refuge. He said in part.

On my return east I made a stop at Dixon, Montana, to visit the Montana Bison Range. Warden Hodges, having been notified in advance, was on hand to meet me and gave me a most cordial welcome. The following day we rode over the range in search of the buffalo. The sky was overcast and soon a cold drizzly rain was driving against us in fitful blasts. However, it did not dampen my spirits, or cool my enthusiasm for this wonderful game preserve. As we rode along the old Indian trail near Mission Creek, suddenly the air was full of ducks—hundreds of them flew in every direction. This was a fine sight, and they seemed to realize that there was no danger as they soon returned to the creek after we had passed. Over near the hills to the right, we noticed a number of antelope, and farther on one or two more. These seemed to be fine specimens, and if the coyotes can be kept in check, there is every reason to believe that in a few years this preserve will have a good-sized band of antelope. About a mile farther on we noticed in the distance a number of dark objects in a depression between the hills, so keeping out of sight as much as possible we rode in that direction. Presently, on mounting a hill, we discovered a herd of buffalo, about half a mile distant. Most of them were lying down, but as we descended the hill, and rode slowly toward them, they were soon on their feet, watching us closely with every indication of leaving at a moment's notice. They seemed to recognize Mr. Hodge's voice and bald-faced

pony, and would only make short runs. In the meantime we edged up closer until near enough to have a fine view of the herd, about one hundred and mostly cows. Among them was a calf a day or two old. Its tawny hide was a conspicuous object among the dark robes of the others. These buffalo were fat and in grand condition, very active and quick in their movements, so noticeably different from the dull sleepy-looking animals confined in our zoos. Here, free and unrestrained, feeding on the rich grasses which cover the hills to the very summit and furnish them with food throughout the entire year, they have amply repaid the efforts put forth for their preservation. No one need longer deplore the fact that they were born too late to see the wild game which abounded in the days of their forefathers, because on the Montana Bison Range can be seen the same picture of wild life as in former days. Here on this wonderful game preserve we can travel over the old historic Indian trail and encounter herds of buffalo feeding along the foothills, bands of antelope standing like statues, curiously watching you or flying like a cloud in the distance, herds of elk high up on the hills and deer in the open glades or along the creek where the wild ducks nest and gather in great flocks. Here all these creatures can be seen in their primitive wilderness, unrestrained and in their natural setting.

Except for a few details, the things that Garretson saw are still there for any visitor to see. Several succcessive dry seasons resulted in severe damage to the grass and it is only now beginning to come back to the stage he described. The antelope have gone, as they have gone from other fenced areas—victims of disease, predators, and perhaps unknown factors—but in their place is a band of Rocky Mountain sheep that look healthy enough although there has been some disease among them. All of the other animals are there as he described them.

While this was the first big-game refuge to be administered by the Biological Survey and was important as the foundation for building the present system, it did not represent the first Congressional action for conservation of the buffalo. The act signed by President Cleveland in 1894, making it unlawful to kill buffalos in Yellowstone Park, was the first federal protection accorded these animals. The creation of the Wichita Game Preserve by Executive Order of President Theodore Roosevelt in 1905 made possible the establishment of another herd on lands administered by the National Forest Service. The American Bison Society offered to provide the animals if Congress would appropriate money for fencing an area. Fifteen thousand dollars was provided and with it 8000 acres were enclosed. Fifteen animals

were placed in the enclosure on October 11, 1907. This was the beginning of the *Wichita National Wildlife Refuge* which, however, did not become a part of the present refuge system until 1935, when it was transferred from the Forest Service to the Biological Survey.

This area, now enlarged to 61,287 acres, harbors 465 bison, the largest herd on any refuge. In addition, the Wichita in 1941 had a population of 181 elk, 630 white-tailed deer, 46 antelopes, and 205 longhorn cattle. Quail and turkeys are plentiful and scores of other species of birds and mammals find a safe home there.

Geologically, the Wichita Refuge is an interesting place. The mountains are rounded domes of ancient rock rising abruptly from a level plain. Many of the ridges are bare save for straggling trees and shrubs clinging to precarious footholds in the crevices. Juniper and scrub oak are dominant, but numerous other trees are present. The area is an arid one, but swift run-off of the meager rains has in time carved out numerous gullies and miniature rocky canyons. The National Forest Service started a program of impounding water, which has been continued since its transfer until now there are twenty-two lakes that provide not only good distribution of water but also excellent fishing in areas it is practicable to open to the public. The fishing pressure is constantly heavy, and stocking may be necessary to maintain the fishing, which is in great public demand.

This refuge was a great boon to the research program of the Service. The presence of four species of big game and of the longhorns made possible the study of such difficult subjects as food preferences and forage requirements of big game, the effects of seasonal use of the range, and eventually, when fully equipped, comparative studies of competition between big-game species and between big game and livestock. To facilitate these investigations and also to give the range a chance to recover, all livestock other than the longhorns was removed. Adequate laboratory and housing facilities were provided and numerous long-time projects are now under way that should some day give answers to many puzzling questions.

Not only is this refuge valuable from a research standpoint and as a bison sanctuary but it contains one of the most interesting combinations of small bird and mammal life to be found on any federal refuge. In the overlapping zones here, where the

northern and southern plains forms meet, one always hopes for the unexpected and is seldom disappointed. Scissor-tailed flycatchers overhead and dickcissels on the fence posts are one duo of diverse origins; wild turkeys, horned larks, and road-runners seem gathered from as many different faunas; sandhill cranes, a prize for any wildlife area, dropped in to the number of sixty on one occasion and overnight raised havoc with the amphibian choristers of one of the little lakes. The following evening the shrunken volume of sound was nearer that of a barber shop quartet than of a great choral society.

The third ranking bison herd protected by the Fish and Wildlife Service, 142 animals, is on the *Niobrara Wildlife Refuge* in north-central Nebraska. The sanctuary lies on both sides of the river for which it is named; its nucleus was the old military post, Fort Niobrara. Made a refuge in 1912, additional lands have been purchased until now 18,719 acres are enclosed by a big-game fence. The land to the north of the river is an irregular plateau cut by dry ravines and small streams. The steep little canyons are heavily wooded with scrub oak and other trees in which such small woodland birds as redstarts, red-eyed vireos, Bell's vireos, and towhees are fairly common.

The area south of the river is made up of rolling sandhills and, together with the north portion, comprises a fine representation of the two types of country characteristic of the eastern sandhill region.

The refuge includes two ancient fossil beds from which more than twenty species of perhistoric animals have been collected. A small musem building at the refuge headquarters, containing a representative exhibit of these fossils, is of great interest to visitors. Among the species represented in these extensive deposits are a three-toed horse, rhinoceros, elephant, camel, and antelope (see B. S. Leaflet 109, Fort Niobrara Game Preserve).

The presence of these fossil beds is due to a fortunate accident of location, but the fine herd of 142 bison was placed there. When the military reservation became a bird reserve, the enthusiasts campaigning to save these shaggy Americans saw an opportunity to create another nucleus herd. Two thousand and seventy dollars was subscribed by the citizens of Valentine, the Chicago Northwestern Railroad, and the National Audubon Society, to fence a temporary pasture, and on June 21, 1913, six buffalos, donated by J. W. Gilbert of Friend, Nebraska, on condition that

they would not be removed from the state, were released in this enclosure. Two others from Yellowstone were added later and from this small nucleus the present herd has grown. The area proved ideal and the present herd, by good management and careful selection of the individuals retained in the breeding stock, has developed into one of the best in the country. Seventeen elk and two white-tailed deer, also donated by Mr. Gilbert, were released at the same time.

In addition to these three big-game species, numerous birds occur within the refuge boundaries, some 250 species having been recorded. Among them the sharp-tailed grouse, bob-white, prairie chicken, upland plover, and the introduced ring-necked pheasant find the environment much to their liking.

In recent years a number of ponds have been created by small dams for the primary purpose of providing a better distribution of water. Incidentally, they provide feeding and resting places for migrating ducks, a few of which spend the winter.

A fourth small herd of bison is maintained on the *Sullys Hill Refuge* near Devils Lake, North Dakota. This reservation is a picturesque, wooded hill district of 994 acres on the old shore line of Devils Lake and is a very popular place with the people of the surrounding territory. Within its big-game fences in 1941, there were 16 buffalos, 10 elk, and 14 white-tailed deer maintained as exhibition herds for public education. The tract also functions as a wildlife sanctuary, benefiting both migratory birds and the resident fauna. There is a small but attractive lake where Canada geese breed in semi-captivity. It attracts an astonishing variety of wildfowl and small birds.

The refuge was originally set aside as a national park by Presidential proclamation on June 2, 1904, under authority of an Act of Congress approved April 27, 1904. It was made a big-game preserve by Act of Congress on June 30, 1914 and was jointly administered as a national park and game preserve by the Departments of the Interior and of Agriculture. By an Act of Congress on March 3, 1931, it was eliminated from the national park system and became a wildlife refuge.

Old records disclose that the original six buffalos brought to Sullys Hill were a gift from city park officials at Portland, Oregon; four white-tailed deer were obtained from the Agricultural Experiment Station at Fargo, North Dakota; and fifteen elk from the northern Yellowstone elk herd of the National Park Service.

The local popularity of this refuge with its exhibition herd of big-game animals is attested by the fact that, in 1939, 20,175 visitors entered its gates.

It is gratifying to realize that the bison, which proved able to thrive in a semi-wild state, is no longer endangered. The number of animals, their wide geographic distribution and careful management insures, so far as human effort can, that at least small numbers of this great plains dweller will always remain with us.

The solution of this particular problem brought satisfaction to the group leading the conservation crusade but no surcease from the necessity of efforts along numerous other lines. The bison is left to those responsible for the administration of the refuges on which they are confined. Reading the old literature and appeals "to save the bison," it is interesting to speculate on the thoughts of some of those departed leaders should they return today and find that the chief problem in managing the herds is that of holding down their numbers to the carrying capacity of the available land. Each year the Fish and Wildlife Service faces the necessity of disposing of from 50 to 250 or more buffalos, the number being governed by the condition of the range and the increase in the various herds.

Animals are first given (if crating and transportation costs are paid) to parks, zoos, and similar institutions keeping live animals. Those that cannot be so utilized are butchered and the meat sold, given to Indians, or donated for charitable purposes.

In 1928, twenty-three buffalos were shipped to Fairbanks, Alaska, and nineteen of them released in the Big Delta region. This herd has now grown to about 300 animals and is in thriving condition. It has spread somewhat into neighboring areas and thus the bison runs at large again on American soil as a truly wild animal,* something that few expected to see again. Others, given by the National Park Service, which is faced with the same disposal problem, and by the Fish and Wildlife Service, are on the Crow Indian Reservation in Montana in a semi-wild herd which the Indians on that area are endeavoring to build up.

ELK REFUGE

The *National Elk Refuge* at Jackson, Wyoming, came into being as the result of another conservation crusade directed at a

* There are wild herds of the so-called wood buffalo in Canada.

specific problem. The elk forming the southern Yellowstone herd formerly wintered much farther south, but settlement of the country and competition of domestic stock deprived them of much of their accustomed winter forage. Despite the efforts of local people to feed the animals, a tragic routine of starvation and death became more or less a regular winter event in Jackson Hole.

In 1906, D. C. Nowlin, then State Game Warden of Wyoming, suggested an elk refuge as a solution of the problem but, like many other conservation suggestions, this one aroused powerful objections. In 1908, a memorial of the state legislature asked Congress to grant to the state five townships on the Gros Ventre River for a winter refuge but it came to nought because of the opposition that developed.

During the winter of 1908–1909, conditions became so bad that the citizens of Jackson Hole subscribed $1000 for purchasing hay and appealed to the legislature for additional help. The state responded with an appropriation of $5000. Dry summers continued to reduce forage while severe winters increased the need so that the plight of the animals could not improve. Finally the pressure of public appeals brought a Congressional appropriation on March 4, 1911 of $20,000 to be made immediately available for feeding and protecting the elk in Jackson Hole and for transferring some of them to other localities.

The Biological Survey was given the task of administering the fund and was thus brought officially into the problem. As a result of studies that season and during another bad winter the following year, Congress, in 1912, passed legislation initiating the refuge project. Money was appropriated and by a combination of purchase and withdrawal of public lands, 2760 acres were acquired by 1916. By popular subscription the Izaak Walton League raised sufficient funds to buy an additional 1760 acres of land, which were given to the government. Since 1935, additions by further public-land withdrawals and purchase have increased the area to 23,950 acres. This, together with leased lands, is believed to be sufficient to provide winter feed for 20,000 animals. Hay is still cut and stored for emergency use, although much of the forage is left on the ground for the elk to harvest for themselves. Continued storing of hay and other feed is required, as in only four winters since 1912 have natural feed and snow conditions been such as to render feeding entirely unnecessary.

During an occasional mild winter the herd remains in the

foothills, while severe seasons drive a great proportion of them into the flat lands that make up a large part of the refuge. The number wintering on the refuge has varied from 3000 to more than 11,000.

There is general agreement among those who have made the most careful studies of this herd that 20,000 head is about the maximum that can be maintained. At that it is one of the greatest herds of game in North America and an increasing number of visitors go to Jackson Hole in winter to see this striking aggregation of big animals. The Elk Refuge is not a fenced preserve and the elk are wild animals entirely at liberty to come and go as they choose. The summer range of the herd lies far to the north in the Teton National Forest and in the southern part of Yellowstone Park. There the elk remain until increasingly severe weather and storms drive them to this lowland wintering ground where they paw the naturally cured grasses from the snow exactly as their ancestors did in ancient days. Only when this feed is gone or when the snow becomes too deep for the animals to obtain it is the hay, stored for just such emergencies, drawn upon. From November to March, depending upon severity of the weather, the animals may need feed at any time, for despite the provision of more than 20,000 acres of winter range, the summer and winter ranges are still badly out of balance. In the early days when the elk problem first attracted attention the herd was probably twice as large as at present but the animals then had much of western Wyoming for their winter range. Fencing for cattle ranches gardually encroached upon their ancestral territory and made necessary the remedies here described.

This herd is kept at or near 20,000 by hunting seasons set to allow surplus animals to be taken before reaching the refuge. Occasionally, when this fails, it becomes necessary to reduce the herd on the refuge. Elk have been shipped to the National Bison Range, the Wichita Game Preserve, and to national forests throughout the West. A number of fine independent herds can be traced to Jackson Hole elk transplanted into regions from which the native stock had long been gone. When transplanting cannot be done on a sufficient scale or the hunting take is too small, it becomes necessary to butcher some of the animals to keep the herd within bounds. Animals that come early and stay late—in other words, the individuals, or "hay burners" as they are called locally, that have shown the strongest tendency to become pauperized and

make the least effort to rustle for themselves—are selected for removal. It is desirable that the elk remain *wild* animals rather than become any more dependent upon man than stark necessity compels.

The waters of Flat Creek and the marshier part of the Elk Refuge provide summer homes for an interesting variety of water birds. In addition to the large number of waterfowl that stop on their spring migrations, such birds as the mallard, shoveller, gadwall, teals, killdeer, Wilson's phalarope, Wilson's snipe, and sage grouse nest there. As the water never entirely freezes on the area, it has been chosen as one of the spots to be colonized with trumpeter swans. Four birds were taken there in 1938 and several additions have been made to the colony since. At present six birds are on the refuge but none has yet been known to breed.

While this is the only major refuge maintained for elk by the Service, there are small herds of this species on the National Bison Range, Sullys Hill, Niobrara, and the Wichita refuges, all fenced preserves maintained primarily for the American bison.

ANTELOPE REFUGES

Hart Mountain National Antelope Refuge in Oregon and *Charles Sheldon National Antelope Refuge* (and the *Charles Sheldon Antelope Range* adjacent to it) in Nevada are the only major units devoted especially to the antelope, although a number of waterfowl refuges, such as Lake Bowdoin in Montana and Malheur in Oregon, contain small herds as do also a number of upland refuges.

Hart Mountain Refuge (220,319 acres) will ultimately contain something like 49,000 additional acres when included private and state lands are acquired. The mountain itself is a gigantic block of tilted lava in south-central Oregon, the western face of which is a basaltic escarpment rising almost perpendicularly some 4000 feet from the floor of Warner Valley. A mountain goat would find tough going at most points on this side, although a few precipitous little canyons notch the wall enough to permit travel into the heart of the mountain on horse back. The eastern slope is more gentle and has been weathered into rugged ridges and deep canyons. The refuge line extends from the foot of the westward wall of the mountain over the summit, down the eastern slope, and onto the desert plateau that stretches far to the east-

ward. Wherever there is soil, sage brush grows as the dominant plant, varying from the scattered and stunted individuals on the 8020-foot summit to miniature trees in the fertile soils of some of the stream bottoms. Aspen thickets grow in the wetter spots on the mountain slopes. Some of the aspens are small bushes twisted and deformed by the annual snow blanket that bears them toward the ground and holds them bent and distorted during the cold period. Others, in the better soils of the mountain valleys, form beautiful groves that are a joy to see. Thickets of mountain mahogany, which here, under favorable conditions, grows into trees of fair stature, are scattered over the drier slopes. In one sheltered valley, which has for years been a favorite camping spot, a small forest of yellow pine grows. These trees have been headed back so frequently by the feeding activities of porcupines that, despite their having trunks of fair size, the trees appear stunted. Some of the larger individuals show the scars of five headings due to the removal by porcupines of all the bark of the topmost branch or branches.

This desert peak of Hart Mountain supports many shrubs that are utilized as browse at some season, not only by the antelope and mule deer but by livestock as well. In addition a variety of wild flowers at times turn entire hillsides into spectacular wild gardens, the climax at moderate elevations usually occurring about mid-June.

A herd of antelope, estimated from 2000 upwards depending on the estimator, ranges over the lower slopes of the mountain and about the desert lakes of the arid plateau to the eastward. During the spring and summer the animals are scattered—the does and fawns on the tableland and lower foothills and the large bucks everywhere, a few even to the summit of the range. In fact, one big buck was seen within a few hundred feet of the geological marker placed on the topmost peak. In late summer and fall the animals gather on the desert plateaus into large herds, sometimes of several hundred animals, and some bands leave the refuge as winter advances. In addition to the antelopes there is a fine herd of mule deer, numbering at the latest count about 3000 animals.

Sage hens in increasing numbers come to drink at the springs and streams on the area as the vegetation recovers from the combined effects of overgrazing and drought.

September is a good season in which to visit Hart Mountain. The wildlife populations of this desert plateau are then concen-

trated along the water courses and the year's increase is present to bring the population to its highest peak. As one travels down a small stream bottom, glowing with a golden waist-high stand of wheat grass, antelopes, roused from their noonday siestas, stream up the slopes on either side. Ducks, mostly mallards, pintails, and green-winged teal, rise by the score from the stream and circle overhead, while hundreds of sage hens flushed by the car alternately sail and flap toward a distant slope. Even a stately buck deer joins the parade of mammal and bird life. A few years of protection has wrought a marvelous change in this little valley which, before the removal of an overpopulation of livestock, was a series of mud holes in a dusty trampled bottom that showed little signs of vegetation.

Hart Mountain became a refuge December 21, 1936, the date on which President Roosevelt signed the Executive Order. The public lands within this refuge had previously been set aside as a part of a game range (September 6, 1935), the order for which was revoked upon the establishment of the refuge. Some of the included private and state lands have been purchased but the money available was not sufficient to obtain all of the scattered private holdings. The crying need of this and several other refuges is for funds to complete the acquisition of tracts of individually owned lands within its boundaries. It will never be possible to administer the areas economically until such purchases are completed.

While Hart Mountain Refuge was not established until 1936, officers of the Biological Survey and the Oregon State Game Commission had dreamed of such an antelope refuge at least sixteen years earlier. In fact, much planning had already been done and the program ultimately carried out was supported by local residents and livestock men as well as by conservationists from all parts of the state. Some of these supporters, years before the refuge became an accomplished fact, formed themselves into "The Order of the Antelope"; this group, which helped in many ways to establish the refuge, still meets once a year at the old camp ground to renew acqaintances, to see the antelopes, and most of all to experience again the joy of living in an out-of-doors teeming with life.

Beyond its special value for antelope, this is an outstanding wildlife refuge. Extending from 4400 to 8020 feet in elevation, and having both an east and a west slope, the Sonoran, Transi-

tion, Canadian and Hudsonian life zones are represented within its borders. It is well watered with springs and streams which, together with the varied topography and vegetation, attract an amazing variety of life to its somewhat arid slopes. Thirty-six species of mammals have been found within the refuge, varying in size from the desert harvest mouse to mule deer bucks, lords of the aspen thickets. A form of the Rocky Mountain sheep, now extinct, was once common here and an effort has been made to establish a herd of a closely related subspecies in its place. It is yet too early to know the ultimate success or failure of this venture. One hundred and twenty kinds of birds have been recorded. The Warner Lakes near the refuge are a famous waterfowl breeding ground. On the small portion of one lake within the refuge boundaries western grebes, white pelicans, Canada geese, and five species of ducks have been found nesting. Numerous mountain birds are present, ranging in size from the tiny black-chinned hummingbird to the golden eagle.

Plans for development include the purchase of all hitherto unacquired lands within the boundary, maintenance of an adequate patrol system, and the building of several control dams. These dams will create and maintain somewhere near 3000 acres of permanent marsh with water that now runs off the mountain to spread out thinly over the great alkali flats to the eastward and then quickly evaporate.

Charles Sheldon National Antelope Refuge (34,325 acres) stands as a monument to the vision and persistence of one man—E. R. Sans, long a member of the Biological Survey. Despite all of the adverse conditions that harried the antelopes of northwestern Nevada through the period 1915–1930, a small band had managed to maintain themselves. Sans persistently tried to sell his refuge idea to everyone he met. Ultimately he succeeded by a near-kidnapping of Dr. T. Gilbert Pearson, then President of the National Audubon Society. According to the story told by both men, Pearson came to Reno desiring to go to Pyramid Lake to see the pelican colony on Anaho Island. Sans agreed to take him only if Pearson would go to see his pet antelope project and Sans finally had his way. Pearson went to the area and immediately saw the possibilities visioned by Sans. Through his interest, the Audubon Society and the Boone and Crockett Club of New York raised enough money to purchase key private lands and donate them to the Government. The surrounding public lands were

added and on January 26, 1931 Sans' dream became a reality when President Hoover signed the Executive Order creating the refuge. It was named for Charles Sheldon, a noted sportsman, who had been particularly active in promoting big-game conservation. On December 21, 1936 an Executive Order created a 549,000-acre game range adjoining the refuge. The original tract is summer range, but the newly reserved land provides ample winter range for the herds. Subsequently some 20,000 acres of scattered privately owned lands were purchased and added to the range. The antelope population rises from 1200 during the summer to more than 7000 in the winter months as animals from the surrounding country drift into these lower tablelands.

Like Hart Mountain, which lies to the north, the Charles Sheldon area contains a big population of both mule deer and sage hens, the two forms which with the antelope are the characteristic game species of these gray-clad plateus. Many of the same species of small birds and mammals are common to both areas, and Charles Sheldon, like Hart Mountain, can ultimately be developed to provide thousands of acres of first-class marshes to the advantage of both big game and waterfowl.

The Charles Sheldon Refuge and Range, unlike Hart Mountain, is composed of several uplifted masses with lower tablelands interspersed. It has many living streams, which ultimately waste their waters in the great alkali flats lying about its edge. These waters will ultimately be impounded on smaller areas back in the range to form permanent marshes and ponds. No one of these will be large, but the aggregate acreage will equal that of one first-class waterfowl refuge of average size. These smaller areas are much sought after by the birds as breeding grounds, so that their development is sure to increase production. On this refuge I once saw seven proud mother pintails each leading a little brood about one small pond that had been in existence less than a year. There was, however, a vast expanse of scattered sage and other plants, which furnished an abundance of nesting cover within easy walking distance for newly hatched downy ducklings.

Aside from water development, the construction and maintenance of adequate administration quarters, the building of an interior patrol-road system, and management to restore the vegetation are the principal present plans for the refuge.

Among other birds, Swainson's hawk—a big slow-moving grasshopper and rodent catcher—is very common. Golden eagles

are numerous, as are the usual varieties of desert birds and mammals. The area as a whole has less timber and consequently fewer timber-loving species than Hart Mountain. It is beautifully adapted for use by the antelope and, together with Hart Mountain, should go far toward assuring the future safety of the antelope.

From these two areas fawns have been taken to help restore antelopes to other areas from which they have long been gone. The most successful of these attempts to date has been in eastern Washington, where the animals are thriving. The interest in antelope, resulting partially from efforts to establish these refuges, has been translated into effective action for the preservation and restoration of this fleet-footed American in many additional states and districts. Today there are many times the number of antelopes in the United States as there were in 1920, and six states again have limited open hunting seasons—a thing that few had ever expected to see again. The seasons are justified, however, as there is more than enough reproduction to keep the herds growing despite partial harvest of the annual crop.

MOUNTAIN SHEEP REFUGES

Four refuges have been set aside in an effort to restore the desert forms of the bighorn sheep. None so far offer protection for the Rocky Mountain subspecies, but three national parks contain good herds of these wonderful animals. Two of the four refuges under administration of the Fish and Wildlife Service provide for the Gallaird's mountain sheep, one for the Texas bighorn, and one for the desert mountain sheep.

The Desert Game Range, largest wildlife refuge in continental United States, contains 2,022,320 acres. Lying in Clark and Lincoln counties in southern Nevada, it was established by Executive Order on May 20, 1936. It includes within its boundaries a part of the Dixie National Forest and, except for that unit, is administered jointly by the Grazing Service, which regulates public grazing, and the Fish and Wildlife Service caring for the wildlife.

This range is primarily for the desert bighorn, a species that for years has barely held its own in the more remote ranges and has vanished entirely from more accessible areas. At the present time there are about 325 animals on this range, although it could carry some 1800. The mule deer, found in limited numbers, is

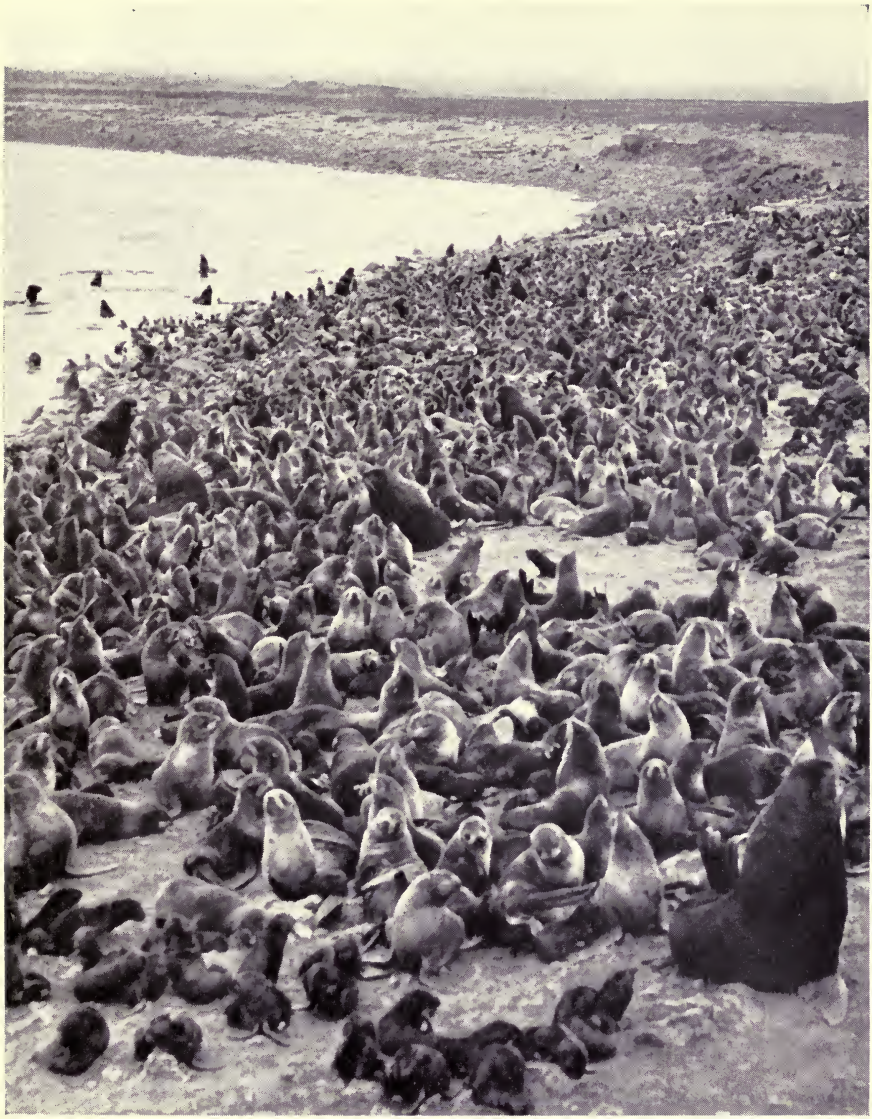

PLATE 13

LITTLE PALOVINA FUR-SEAL ROOKERY ON ST. PAUL ISLAND

Together with other rookeries on this island and adjoining St. George, this constitutes the most valuable herd of fur animals in the world.

Fish and Wildlife Service photograph by H. B. Carr

PLATE 14

HERDS OF BISON ARE FOUND ON FOUR NATIONAL WILDLIFE REFUGES

Upper. An albino calf, born on the National Bison Range, has now grown into a husky animal.

Fish and Wildlife Service photograph by Robert S. Norton

Lower. A fine bull on the Wichita.

Fish and Wildlife Service photograph by H. W. Henshaw

the only other big game. Coyotes and bobcats are also found in the three small mountain ranges that form the major part of the reserve. The sheep spend the summer in the higher parts of the area, utilizing the lower ranges in fall, winter, and spring. The flat intervening valleys are of little wildlife value, although interesting cactuses are found there and a scant population of desert rodents and small birds.

The Sheep Range has a fair supply of water, the other two much less, but even the former is sparsely vegetated for it is in an arid land. On the slopes are scattered small junipers and piñon pines, undergrown with yuccas and various shrubs and grasses. In a small valley a yellow pine stand, known locally as the "Hidden Forest," is a welcome sight amid the dry hot valleys and equally dusty slopes. On this refuge, there is also a fine growth of that queerest of American trees, the Joshua tree or tree yucca. Its variety of odd shapes and stiff foliage cast weird shadows by day and form silhouettes exaggerated into grotesqueness in the moonlight. Queer as it may seem to human eyes, this weird forest furnishes food and welcome shelter to a host of small furred and feathered folk. Gray flycatchers, sage sparrows, tiny Virginia's warblers, and the brilliant Scott's orioles are common birds of the area, while golden-mantled squirrels, chipmunks, gray foxes, and spotted skunks are prevalent mammals.

In the low hot valleys where cactuses, creosote bush and mesquite form the dominant vegetation, the Gambel's quail, Texas nighthawk, cactus woodpecker and California shrike find congenial homes, along with jack rabbits, the kit fox and the big desert kangaroo rat.

Only Charleston Peak (11,910 feet) in the Dixie Forest and the highest point in the Sheep range (9706 feet) rise high enough to provide any departure from the Sonoran zone. The Transition zone is the home of the yellow pine and silver fir. Associated with these trees are the pigmy nuthatches, Wright's flycatchers, green-tailed towhees, porcupines, badgers, mule deer and mountain sheep.

One of the most striking wildlife pictures that any naturalist could wish to see was spread to view for a party of four on the edge of the Hidden Forest. Three bighorn rams—each with a head to excite admiration—rose from their beds as our car approached and, after calmly looking at us, moved majestically off up the ridge into the purple mists of the twilight. The splendid

animals, the wild beauty of the spot, and the mystic light of the desert sunset painted one of those unforgettable masterpieces that Mother Nature occasionally unveils to those who persistently seek the out-of-doors.

Above 9000 feet the bristle-cone pine and the limber pine become the common trees and on Charleston Peak, at about 10,000 feet, a pure stand of bristle-cones, undergrown by dwarf juniper, furnishes suitable homes for the goshhawk, saw-whet owl, chickadee, Audubon's warbler, pine siskin, Clark's nutcracker, and Mexican crossbill. Some 59 forms of mammals, and 160 of birds, have been found on the Desert Game Range—an astonishing number considering the aridity and scanty vegetation of the tract.

The chief present problem is that of protecting the desert sheep from human poaching and keeping a watchful eye on such predators as golden eagles, coyotes, and bobcats, all present in some numbers, to insure that the small herd is not reduced by their activities. When numbers fall as low as with this bighorn herd, every individual counts, and a degree of predation that might be ignored elsewhere cannot be tolerated here. On a number of occasions golden eagles have been observed to take lambs. Until the herd is built up to a more secure numerical level, refuge personnel have been authorized to kill any creatures found preying on the existing remnant band.

As to management of this range, better distribution of water by development of new seeps and springs is most desirable and construction of interior patrol trails, sufficient to allow the limited personnel to maintain efficient protection, is needed.

The Kofa Game Range (about 660,040 acres) and the *Cabeza Prieta Game Range* (about 860,040 acres), both established by Executive Orders signed on January 25, 1939 under the conditions of the Taylor Grazing Act, are also jointly administered by the Grazing Service and the Fish and Wildlife Service. Like the Desert Game Range, they include arid mountain ranges on which are found remnant herds of bighorns. The form they retain, the Gallaird bighorn, has all but vanished from the earth. There are estimated to be some 500 individuals on the two ranges —not many, but a nucleus from which it is hoped to build much larger herds. Peccaries and a small form of mule deer also find protection here, it being estimated that about 100 of the former and somewhat fewer of the latter are there at present. In addition,

a long list of desert-dwelling species are found in the cactus, mesquite, and creosote bush that dominate the vegetation of these arid lands. The Kofa Range contains the only known individuals of the fan palm (*Washingtonia arizonica*). These trees, which are from ten to eighty feet in height, are found growing on about eighty acres in deep, narrow canyons in the most rugged part of the area. Needless to say, they, along with the few mountain sheep, are being carefully guarded. Another plant that deserves mention is the great sahuaro or giant cactus found intermingled with a host of others of its family.

Of all the refuges in the federal system, these two are the driest. The landscape is characterized by numerous low but exceedingly rugged mountain ranges, which are frequently only barren rocks projecting above the desert. Yet, in these sun-baked ranges the desert bighorns find conditions so suitable that, if human poaching can be controlled, good herds of these remarkable desert dwellers may again travel their arid slopes.

The need of more widely distributed watering places is being met to some extent by the provision of deep and shaded catchment basins, where water from the infrequent rains can be stored.

It is hoped that the Mexican government will dedicate the extensive mountainous areas that adjoin the Cabeza Prieta to protection of mountain sheep in their country and thus make the project an international one.

The San Andreas National Wildlife Refuge (about 57,215 acres), created by Executive Order in 1941, is the latest of these sheep refuges to be established. It is part of an exceedingly rugged mountain range in south-central New Mexico and contains only a few animals of the once-common Texas bighorn. Probably not more than twenty-five head remained at the date of establishment, and it will require strict protection and skillful management to restore their numbers. Part of this refuge is in a Taylor Grazing District and the remainder in the Jornada Experimental Range maintained by the Forest Service. The two agencies have been most coöperative.

Mule deer are common here, perhaps too common for the good of the pitifully small surviving band of bighorns. Investigations have revealed that overuse by deer in some districts is already damaging the reserve food supply on which the sheep must depend in bad seasons. Should this condition continue, it might destroy the last chance of rebuilding the bighorn population—

the primary purpose of the refuge. It may prove necessary to reduce greatly the number of deer.

In addition to the big-game species, Gambel's and scaled quail are found in small numbers, along with a few mountain lions and the inevitable coyotes and bobcats. Golden eagles are among the birds found, and the remarks on their predatory activity against the bighorns on the Desert Game Range apply with even greater force here where the sheep population is at a lower ebb. Every effort will be made to reduce predatory pressure on this band of bighorns while it is struggling to survive and increase.

Development of a more adequate water supply, better distributed over the range, is as much a problem as on the other desert areas. Adequate patrol facilities must also be provided, and this involves construction of trails into the more inaccessible areas frequented by the mountain sheep.

FORT PECK

Fort Peck Game Range (970,000 acres), another of the areas administered jointly with the Grazing Service, was established December 11, 1936. It consists of the land and water area acquired by the War Department for the Missouri River flood-control project, said to be the largest undertaking of its kind in the world. Unlike areas previously discussed, it contains no single herd of big game in need of restoration or protection. It does, however, offer a magnificent opportunity to carry out a wildlife restoration program in the plains area—in a country which was once one of our greatest game resorts. Antelope, mule deer and white-tailed deer now occur on the range in limited numbers. They are already showing a moderate increase although, because of many complicated land problems, the area has not yet been placed under full administration. In addition to the big game now present, buffalos, elk and the plains form of the mountain sheep were all found here in bygone days. The sharp-tailed grouse is present in limited numbers, but the range offers splendid opportunities for building a much greater population of these birds. The great reservoir affords a valuable resting place for migratory waterfowl in a land where water is usually not too plentiful for their needs, particularly in the fall migration, and surveys indicate the possibilities of providing increased food production. Some of the tributary streams and gulches offer good opportunity for shallow water

impoundments to provide a greater food supply for waterfowl and possibly a greater natural production of fishes.

ALASKA GAME REFUGES

During 1941 the big-game refuge program was extended to two areas in Alaska. They are not intended as sanctuaries although, if necessary, both can be closed to hunting at any time, Rather, the areas were set up to prevent too great encroachment on the natural ranges of the animals involved and to facilitate management maintaining the stocks at a high level.

A large part of Kodiak Island has been reserved as a range for the brown bear. This magnificent creature, largest of all terrestrial carnivorous animals, attains its greatest size on Kodiak Island. Sportsmen from the world over visit Alaska to hunt these great beasts which are still plentiful. However, the total population of so huge an animal can never be large and a most careful check on the hunting is necessary if the numbers are to be maintained. At present all of the reserved area is open to hunting under regulations of the Alaska Game Commission.

The Kenai Moose Range was established to safeguard the largest herd of these huge animals on American soil, a band which also contains the largest individuals known.

The Kenai is ideal moose country. It is dotted by myriads of tundra lakes and ponds, particularly in the north half, with the central and southern part studded with larger lakes separated by willow- and alder-grown ridges. The Russian River, most famous of Alaska's marvelous trout streams, forms a part of one boundary. The Kenai River flows through the refuge on its journey from the lake of the same name to the sea. And the Kasilof River, another beautiful stream, whose every eddy was populated with green-winged teals and pintails on an early August visit, flows for most of its course through this area. Beautiful glacier-fed Tustamina Lake, source of the Kasilof River, lies entirely within the refuge and provides about its shores the main wintering range for the moose. Forests of black spruce and birch edge the lakes, giving way to stunted bushy alder and willow growth on the higher land.

Around these forest-bordered lakes, white-winged crosssbills, pine siskins, Alaska jays, kinglets, redpolls, chickadees, robins, and many other birds are present in abundance. The tiny streams

flowing into the lake are filled in season with the runs of spawning red salmon, a prime attraction to both black and big brown bears. As soon as the runs begin, the bears beat great trails through the lush vegetation that chokes the stream bottoms.

The boundaries of the moose range have been drawn to omit the southern part of the Kenai Peninsula, which seems to offer possibilities of agricultural development, but the boundaries do enclose an area large enough to provide ample room and food to maintain the herd at its present estimated size of between 3000 and 4000 head. One area, which has been closed to hunting for several years under an Alaska game law regulation, will remain a refuge, while on the remainder of the tract hunting for moose and other game will be permitted under careful regulation.

No development is contemplated and patrol will, for the present, be carried on largely by pontoon-equipped airplanes, which can land on any of the scattered lakes. Plans have been made for one or more field biologists to conduct population and other studies in order that this great wildlife asset may be properly managed.

FUTURE NEEDS OF BIG-GAME REFUGES

If the ideal of having within the national wildlife rufuge system a home for every American species of big game is to be attained, several additional units will be needed to provide for such species as mountain goats, caribou, moose (in the United States), and grizzly bears. The last-named animals will undoubtedly be the most difficult to provide for, although preliminary studies have revealed at least two possible suitable areas. In addition to refuges for preserving seed stocks of important big-game species, there is also need for several upland areas to provide adequately for the numerous upland game birds and smaller mammals. The accompanying map indicates general districts in which two or more suitable tracts can be found. The symbols are not intended to indicate any special tracts, but rather to mark ecological zones in which the combined ranges of several species not now provided for occur. Whether the ideal of a refuge for every species will ever be attained cannot now be accurately foretold.

The second pressing need is for funds to purchase private lands within existing big-game and upland game refuges. Many of the owners are ready and anxious to sell. Whenever it is possi-

ble to get all of these lands, administration will be improved and cost of operation decreased.

The third need is for improved live-trapping techniques to facilitate transfer of stock to districts that have become depleted.

CHAPTER IX

General Wildlife Refuges

The general wildlife refuges include those of no outstanding value for any one group or type of wildlife, but they embrace such a variety of conditions as to fit well into the general program designed to preserve good samples of environment in all the life zones of the country. They harbor typical communities of resident wildlife as well as the plants upon which they depend. They also provide safety islands for all migratory species that find the conditions to their liking. Such refuges become breeding grounds which produce stocks of resident game that may be drawn upon to repopulate depleted districts. This is one of the most important functions that refuges play in the economy of game birds. In plain words, such areas provide accident insurance for game species by holding reserve stocks to be used to offset decimation of stocks by unfavorable climatic conditions, disease, or a too great harvest of the game crop in any locality. Such local depletion is a real problem for every game administrator, as the difficulty of distributing hunting pressures equably enough over an entire state to avoid overkilling on some areas and underkilling on others is almost insuperable. Effort is made, of course, to hold such inequalities to a minimum but even so there are always gaps to be filled. Formerly game farms were relied upon entirely to supply the needed stock, but there now is a growing tendency to use wild live-trapped birds and mammals for restocking. Several factors have stimulated this trend. The method is usually more economical; the percentage of survival of wild stock is normally much higher than that of pen-reared stock; the transplanting of species that may not be successfully reared in captivity is possible; and new techniques of live-trapping and handling have been developed which greatly reduce losses and the time consumed in handling the animals.

State officials have utilized state and privately owned lands as sources of supply whenever possible, but they are also resorting to federal refuges in an increasing degree. As the food plantings

on the newer federal units mature, the production of usable surpluses of wildlife will undoubtedly increase. A corresponding increase in the utilization of this stock seems logical. Various state game commissions have transplanted from federal refuges to depleted districts during 1940 and 1941: 44 antelopes, 15 mule deer, 998 white-tailed deer, 51 elk, 2 beavers, 20 minks, 1313 muskrats, 386 raccoons, 17 bob-whites, 11,215 ring-necked pheasants, 50 wild turkeys and more than 30,000 fishes. In addition, the Fish and Wildlife Service has moved 25 mountain sheep from one refuge to another and transplanted 20 trumpeter swans from Red Rock Lakes to other refuges.

It is not possible to discuss each of the twenty-five areas classed as general wildlife refuges. Some of them are small areas of coastal beaches and mud flats for migratory shorebirds; these have been acquired with the thought of future extension to provide for waterfowl and other wildlife usage. One, the Istopoga Crane Refuge, is a leased area containing several marshes on which a large number of Florida cranes form winter roosts. It also has some value for wild ducks.

Chinsegut Hill (2033 acres) in Florida was given to the Service in 1932 by Colonel Raymond Robbins. It is a beautiful environment in which waterfowl, quail, and many non-game birds find conditions to their liking.

The Wilson Wildlife Refuge (1588 acres) in Georgia was also a gift to the conservation movement by Dr. F. C. Wilson, for whose father it was named. This area, surrounding a cypress-fringed lake, consists of rolling timberlands and open fields. The cypress pond is a favorite haunt of the wood duck and that queer, snaky denizen of southern swamps—the water-turkey or anhinga. Numerous species of northern ducks also use the area during their migrations and in winter. Because of the varied and extensive plantings that Dr. Wilson had carried out for years about his home the area provides suitable habitat for many songbirds and small mammals. There is almost continuous wildlife activity observable from the veranda of the house. Gray squirrels and woodpeckers of several species furnish most of the show, although cardinals, mockingbirds, and Carolina wrens are prominently audible in the medley of sounds and songs.

The Benton Lake Refuge in Montana, formerly a noted waterflowl resort, has, since the loss of the water necessary to flood it, become largely useless for birds. It still retains value for general

wildlife purposes, however, and has been transferred to that status. If it should ever again become possible to refill the lake, the refuge would return to its status as a first-class waterfowl marsh.

The Aleutian Islands Refuge is the greatest of all those in the general wildlife classification. Extending through the north Pacific more than a thousand miles, it includes, with few exceptions, all of the islands large and small in the mighty Aleutian chain. This refuge undoubtedly ranks first in the number of protected birds. Scattered through its entire length are hundreds of colonies large and small of many sea-bird forms; typical examples of these have been described in the chapter "The Great Bird Cities of Alaska."

In addition to the birds, sea lions, a fine and growing population of sea otters, and blue foxes, reared on numerous islands, are conspicuous. Caribou and the great brown bears are present on Unimak, easternmost island of the refuge. Except for these forms and for migrating fur seals, which pass through Aleutian waters as far westward as Atka in their migrations, mammals are neither plentiful nor conspicuous and are confined to introduced ground squirrels and to native mice and shrews on a few islands.

Alaska has two other refuges in this class—the Curry Bird, Fish, and Game Refuge and the Alaska Railroad Muskrat and Beaver Refuge—established to prevent extirpation of wildlife along the line of the railroad.

GENERAL UPLAND AREAS

Within the continental United States there are at present five large upland areas which are the most important refuges of this class—one each in Maine, South Carolina, Georgia, Mississippi, and Kentucky.

Moosehorn National Wildlife Refuge, Maine, established in 1937, is one of the most interesting of these upland units. Its 14,441 acres consist of a medley of small lakes, alder bottoms, and birch- and conifer-clad rolling hills. Included within its boundaries is an area bordering on the St. Croix River that can easily be developed into a first-class waterfowl marsh by a comparatively inexpensive dike which it is planned to build at the earliest opportunity. The land for the refuge, which lies close to the Canadian border near the town of Calais, was purchased with

funds made available in 1934 and 1935, but was not put under administration until a somewhat later date. Its chief value at the time was conceived to be as a woodcock breeding area, and also as a major concentration point for individuals from farther north and east starting their fall flight. It is on this refuge that biologists from the Coöperative Wildlife Research Unit * at the University of Maine have carried out many of their studies which will result in a comprehensive report on the life history and management of the woodcock. It was here that experiments were made in cutting artificial openings in the alders to provide "singing grounds" for the male birds. The results definitely indicate that selection of nesting sites can be influenced by such cuttings. Anyone who has witnessed the wonderful evening flights of the woodcock can appreciate the desirability, from the birds' standpoint, of having such openings available. Cleared areas of as little as half an acre seem to have sufficient value to attract the birds. Additional experiments are being conducted to learn whether or not the shape and location of the opening in relation to other topographic features affect their use by these elusive birds.

Moosehorn contains good trout waters in which fishing by the public is permitted, and furnishes homes for fine populations of ruffed grouse and white-tailed deer, as well as for an occasional moose and bear. Development and management plans aim to maintain the unit as a special woodcock range and to increase its use by waterfowl. A small amount of timber cutting is now permitted; this will gradually increase the existing second growth matures.

The Carolina Sandhills National Wildlife Refuge is in the piedmont plateau between Rockingham, North Carolina, and Cheraw, South Carolina. It lies just south of the northern boundary of the later state and is bordered on the east by U. S. Highway No. 1. The soil is poor and covered with a rather thin growth of scrub oaks, Virginia pines, and other species on the uplands. The stream bottoms, in contrast, are sometimes dense swamps of gums and other water-loving trees and shrubs. This land was part of a Resettlement Administration land-purchase project, 39,168 acres of which were turned over to the Fish and Wildlife Service for a refuge in 1939. At that time, headquarters buildings, a good system

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of trails and fire breaks, and several artificial lakes were already in existence on the property. Physical developments still needed and planned include the impounding of a number of additional lakes, and the planting of trees, shrubs, and perennials to increase the cover and food supply which at present is somewhat too limited for the best wildlife production. These plantings will be little more than generous spot plantings placed in such a way as to have an opportunity to spread naturally. Because of the poor soil and generally scant vegetative cover, improvement of this refuge will be somewhat slow except along the streams where fine deer and turkey cover already exists.

Both deer and turkey, long absent, have been reintroduced and are doing well. Bob-whites have already increased to a near carrying capacity, considering the food as present available. Cottontails, gray squirrels, raccoons and opossums are among the small mammalian inhabitants that may be expected to increase with protection. Small birds of many kinds resort to the area either as migrants or as residents, while a surprising variety of water birds have already found and utilized the newly created lakes. When additional waters have been impounded and given time to develop aquatic vegetation and small animal life, increased use of these lakes may be expected. The larger lakes have been stocked with fishes and will provide an acceptable local recreational and food resource. Scattered individuals of the Carolina beaver have been trapped and brought to the Carolina Sandhills and other refuges in the hope that this nearly extinct southeastern form may be perpetuated. If the project succeeds, these refuges will become a source of animals for future restocking of protected areas. At present, despite closed seasons in many states, beavers receive little actual protection in the South. This is due both to the general lack of conservation thought and understanding in the isolated communities where the animal still survives and to the comparatively small and too frequently untrained enforcement staffs available for protective work.

The Carolina Sandhills provide lands on which game-management experiments with quail are being carried on. Controlled hunting also will be tried here in an effort to develop an effective and inexpensive method of limiting the harvest of an upland game bird to the crop produced. Most systems that are really effective are too expensive to be applied generally by game authorities. In this and other states such trials are being con-

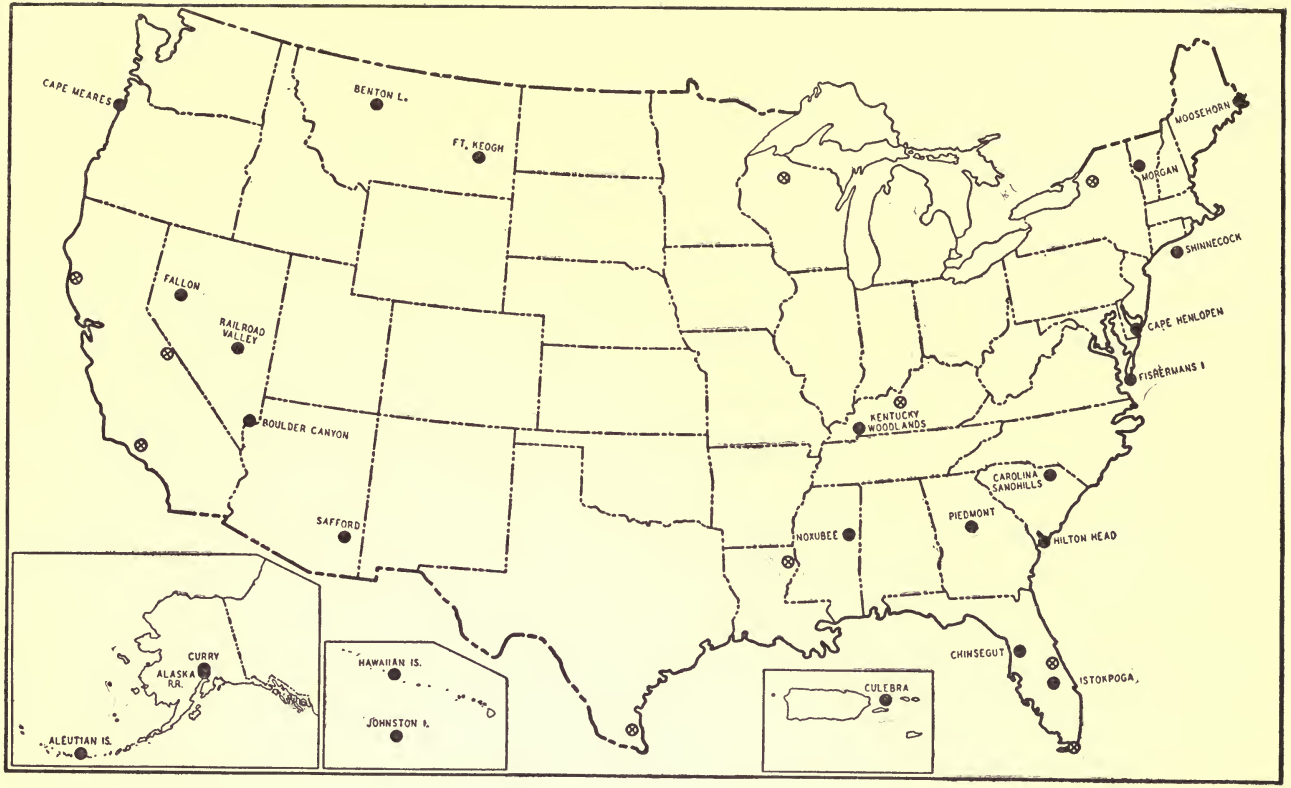

FIG. 3. General wildlife refuges administered by the Fish and Wildlife Service as of March 1, 1942. Crossed circles indicate general regions in which such refuges are desirable. In some cases it may be possible to combine these with a needed big game area.

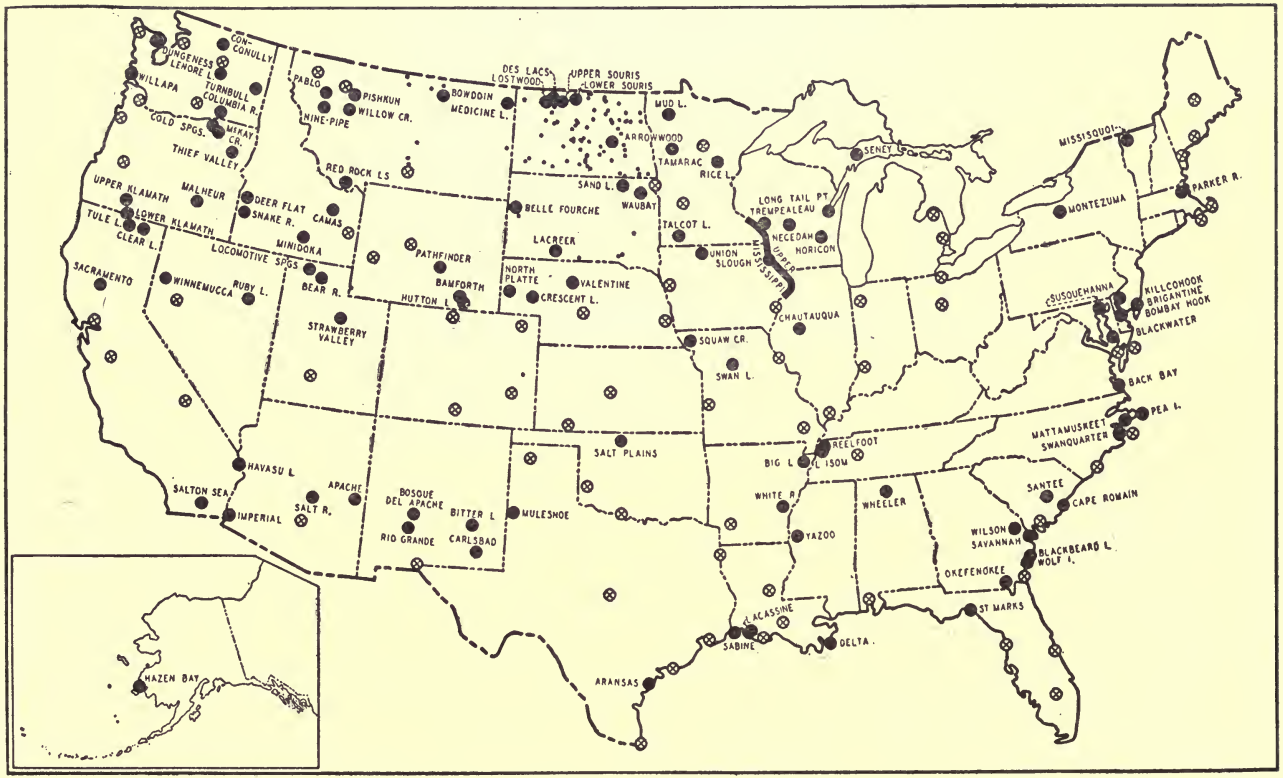

FIG. 4. Migratory waterfowl refuges administered by the Fish and Wildlife Service on March 1, 1942. Large black symbols represent major refuges; small dots indicate easement refuges; other symbols indicate areas in which development of additional marshlands is desirable.

ducted in close coöperation with state game departments who are much interested in developing better harvesting methods.

The Piedmont National Wildlife Refuge, another unit acquired through the Resettlement Administration in 1939, contains 28,004 acres of land. It is located near Macon, Georgia, and consists of badly eroded hill land, some of which will require much erosion control before it can be started on an adequate cycle of revegetation. Complexity of administration here is increased by the fact that much land within the boundaries of the refuge is still privately owned. Some of this, checkerboarded with the publicly owned land, must be purchased before completely effective control can be established. However, purchase of every individual holding may not only be unnecessary but possibly undesirable from the wildlife management point of view. The present effort to associate the small land owners within the refuge boundaries in a coöperative wildlife-management program is a unique experiment, which if successful over the years might make it desirable to keep the people on the land. These small farmers, whose income is often below subsistence levels, are helped by employment on the refuge whenever there is suitable work and sufficient funds to pay for it. They maintain roads, clear fire lanes, fight fires, plant trees and shrubs, control erosion, and where bits of land exist that can be farmed cultivate them on a share-cropping basis. They are also encouraged and assisted in applying to their own lands simple and inexpensive soil-erosion control and wildlife-management practices. At present bob-whites and cottontails are the two chief game species that can be encouraged by management.

While at this writing it is too early to predict the outcome of these efforts, the response of the people, both white and colored, has been encouraging and it is quite possible that a combination of game production with controlled hunting may effectively supplement the income of families stranded on scattered hill farms too small and too poor to provide a living.

Fire lanes and fire towers, with residence for a lookout, were on the area when it became a refuge. Since its acquisition, a headquarters has been provided, and a substantial erosion-control program inaugurated. The first job is to stop the loss of soil, which was occurring on a big scale. Revegetation is, of course, one of the chief remedies, as a growth of weeds of any sort is preferable to denudation. The severely eroded lands are incapable of pro-

ducing any crop, even of trees or wildlife, and it will be many years before they can become normally productive. However, there are areas of stream bottom as well as certain hill lands that are sufficiently vegetated to provide both food and cover for wildlife. With protection and good management, these are already producing an increasing number of wild creatures.

The patchwork ownership prevents proper management of such large forms as the turkey and deer until some of the scattered holdings within the largest block of government lands are acquired, but smaller wild things can be readily increased. Raccoons, opossums and gray squirrels are among the mammals that can be restored under present conditions, and bob-whites have quickly responded to the management program. Carolina beavers have also been introduced with the hope of establishing a good colony of them. Not only will they be a valuable addition to the fauna but it is expected that to the extent they are successful they will contribute to the erosion-control program.

The Noxubee National Wildlife Refuge of 38,239 acres, located near Starkville, Mississippi, is a third refuge derived from the Resettlement Administration, although it was not established until 1940. Government-owned land here is in an almost solid block and administrative problems are consequently simplified. At the time of acquisition, the road system, fire towers, and headquarters were substantially completed; hence, the time and effort of the Service personnel have been devoted to wildlife. Bluff Lake, a shallow 900-acre body of water, had also been impounded by the Resettlement Administration and their successors. It promises in time to become a fine waterfowl area, although present turbidity of the water retards development of aquatic vegetation. Persistent planting, together with controlling erosion, is relied upon to solve the problem. Despite this handicap, ducks of a dozen different species have already visited the lake during migration.

Like the other areas acquired from Resettlement purchases, the Noxubee consists largely of poor or worn-out lands that require revegetation and a long period of protection before they can be restored to full productivity. This area, however, contains somewhat more swamp and lowland and consequently better soil than some of the others. Because of the diversity of environment —swamp, upland, timber, lake, streams, and open fields—Noxubee will ultimately offer good living conditions for every wild

PLATE 15

OVER TWENTY ARTIFICIAL LAKES IN THE WICHITAS PROVIDE WATER FOR WILDLIFE AND FISHING FOR LOCAL ANGLERS

This six-pound bass from Quanah Parker Lake would make most anglers happy.

Fish and Wildlife Service photograph by Ernest J. Greenwalt

PLATE 16

THE WICHITA MOUNTAINS NATIONAL WILDLIFE REFUGE WAS ONE OF THE FIRST FEDERAL REFUGES

Upper. Wild turkey gobblers fight for mate.

Lower. Hunting Horse, 95-year-old Kiowa Indian and former army scout, tells how the Indians hunted buffalos in the Wichitas.

Fish and Wildlife Service photographs by Ernest J. Greenwalt

creature that once lived in central Mississippi. Beavers have been restocked and turkeys and deer will be restored. Other game species, such as the bob-white, raccoon, squirrel, rabbit and opossum, are already present and increasing in numbers. Pileated woodpeckers are common and such southern favorite as cardinals, mockingbirds and Carolina wrens are readily visible and audible. In proper season, swallows of several species flit over the lake, and wood ducks and mergansers frequent the quiet wooded backwaters of a small tributary.

The development plan is one of long-time biological rehabilitation, which includes increase in the supply of such wildlife food plants as are deficient, maintenance of the diversity and good distribution of the cover, and control of soil erosion. With the limited funds and labor available, this will require a period of years, but every advantage will be taken of natural ecological changes.

Kentucky Woodlands National Wildlife Refuge, because of its favorable location and development possibilities, is one of the most, if not the most, important of the Resettlement acquisitions that have been made a part of the national refuge system. It is a long low ridge lying between the Cumberland and Tennessee rivers, a few miles from Paducah, Kentucky, famous as the ancestral range of Irvin S. Cobb. This area, largely covered by a fine and varied stand of hardwoods, chiefly oaks, has had a turbulent history. It was once dominated by charcoal burners and had an iron works which, like many other such furnaces, depended on local supplies of low-grade ores. With the development of the higher grade and more plentiful deposits elsewhere, this working was gradually abandoned, leaving stranded a remnant population with a low subsistence level. The Resettlement Administration had purchased many of their holdings and the families on them had been moved to farms on which they had a better chance for a living. With the traditional mountaineer's devotion to their bit of soil, however, some of them hung on and have been a problem for the Fish and Wildlife Service.

The main purpose of the purchase of the lands was to give these people a chance to improve their condition and a number of subsistence homesteads had been planned before the area was made into a refuge. These have been maintained and the families, living in good, though inexpensive, homes with a plot of ground for garden and crops and equipped to keep chickens and a cow

if desired, are each employed for part of each month on fence and road maintenance and patrol, as fire guards, and on the thousand and one odd jobs that are always present on these 46,522 acres of upland timber.

A remnant of native wild turkeys has been building back under protection until at present there is a fair stock of this king of American game birds. White tailed deer are plentiful, and surprisingly enough small herds of fallow deer and the European red deer maintain themselves on the area as wild herds, descendants of animals introduced into this part of Kentucky many years ago. A few ruffled grouse are also found in some of the heavily wooded bottoms.

The main axis of the Kentucky Woodlands Refuge, lying generally north and south, roughly parallels the great rivers on either side. Construction of the Gilbertsville Dam, farthest down river of the great series of impoundments planned by the Tennessee Valley Authority, is now under way. This dam, which will impound a lake with some 1800 miles of shore line, lies just north of the north boundary of the refuge. It will flood some of our lands but by a coördination of purchase plans between the T.V.A. and the Wildlife Service, all lands between the present boundaries of the refuge and the high-water line will be purchased, giving a common boundary to the two projects. The mighty lake thus brought to the very edge of the refuge will add immeasurably to its wildlife value. By a change in the management program, additional quantities of waterfowl food plants can be produced in the smaller bays and backwaters within the refuge and on the adjacent wet but unflooded shore lines. There will be a real advantage to both agencies in complete ownership of the shore line and adjoining territory for so many miles. It will permit wildlife developments of a type that might not otherwise be possible because of potential malarial hazards and will relieve the T.V.A. of the expense of malarial suppressive measures on this part of the lake. It is confidently expected that this combination of land and water will within a few years develop into one of the greatest wildlife reservations of the entire Mississippi Valley. Every resident species of wildlife and all the migratory birds that utilize this part of the valley of the Father of Waters as an avian highway will find conditions to their liking. There are already two small artificial lakes not affected by the great impoundment. These are now utilized by waterfowl as shelter areas in bad storms

—a use that will undoubtedly increase as the big lake attracts and holds more and more birds.

Boulder Canyon National Wildlife Refuge, a huge area that includes Lake Meade and the adjoining mountains included in the Reclamation withdrawal, was created by agreement with the Reclamation Service in 1933 but is now a wildlife refuge under the Coördination Act of 1934, which authorized the Fish and Wildlife Service to enter upon any federally impounded waters to create refuges and take measures to safeguard the fish and other aquatic life.

Mountain sheep along the rocky walls above Lake Meade attract great attention from visitors who enjoy the novelty of watching this sure-footed dweller of the rock crags from the comfort of a motor boat. This herd, increasing slowly under protection, together with those found on the Desert Game Range to the north, offer the two most promising nuclei for the preservation and ultimate restoration of the species to much of its former range.

The refuge contains 658,497 acres of land approximately equally divided between Arizona and Nevada. The great man-made lake occupies most of the area but the rugged crags and dry valleys that formerly edged the great canyon, now filled with water to the depth of 500 feet (maximum 589 feet), offer favorable conditions for many desert mammals and birds. The Gambel's quail and such unusual small birds as Abert's towhee, verdin, and black-throated sparrows are abundant.

Toward the upper end of the lake, the lower part of former valleys of the Virgin River and Muddy Creek are now covered with many feet of Colorado River water. The Service is building impoundment structures there that will flood some 1500 acres to be stocked with aquatic and semi-aquatic food plants for the increasing numbers of waterfowl that are using the lake as a loafing ground. The American egret and its beautiful miniature cousin, the snowy egret, have already found these partially completed impoundments, and, together with wood ibises, blue herons, white-faced glossy ibises, and night herons, hunt frogs and other tidbits along the muddy shores. Ducks are already using the waters in increasing numbers, seemingly anticipating completion of the projects and the chance to harvest lush crops of food. Because of the location it is believed that this comparatively small development will be of exceedingly great value in the national waterfowl program.

Railroad Valley National Wildlife Refuge, a great flat alkaline valley in Nevada, is in a way one of the unique projects of the system. The lands cost nothing as they were a little used part of the public domain. A test well, drilled during World War I in search of potassium, produced an artesian well which has continued to flow since that time. Gradually it formed a series of ponds and marshes. These developed naturally into a fine waterfowl breeding ground which, acre for acre, produced as many waterfowl as the better refuges. Investigation revealed several flows of artesian water as varying depths, all of the peculiar quality that makes this area so productive. The management plan contemplates the gradual development of additional wells—a program necessarily slow to prevent the additional wells from diminishing the pressure so as to destroy those now flowing. Several wells and several hundred acres of marsh have already been developed, and there is apparently a chance for much more extensive achievement. At present Railroad Valley, while it has potential value for waterfowl, is classed as a general refuge for all desert wildlife.

FUTURE NEED

In order to install a federal refuge unit in each of the major ecological communities of the United States, less than a dozen additional reservations are needed. This is the minimum program, but after it has been met we may well re-examine the entire plan to determine whether supplemental areas are needed. At present none are known, but changing conditions and times may render acquisition of additional areas advisable or, on the other hand, make it unnecessary to retain some existing unit.

CHAPTER X

Mysterious Okefenokee

Okefenokee, the "land of the trembling earth," became a part of the national wildlife refuge system in 1937. Many persons who had long worked for the preservation of this famous swamp saw their efforts rewarded when the Biological Survey purchased nearly 300,000 acres from the Hebard Lumber Company. More is being added from time to time until, at this writing, some 327,000 of this nearly half-million-acre expanse is within the refuge or in process of acquisition.

This unique refuge defies classification. It might be considered a migratory waterfowl area, for the summer wood duck population is large and the number of wintering ring-necks, mallards, pintails, and black ducks sometimes equals that of many waterfowl refuges. It is so huge, however, that one may travel for hours and never see a duck, even though a normal population is present. It might be considered a big-game refuge, for black bears and deer are plentiful in its somber depths. It might also be considered a general wildlife refuge because of the abundance of raccoons, opossums, otter, herons, egrets, and swarms of wintering robins and myrtle warblers. It has populations of a variety of wild creatures equal to those found on the best of this type of refuge.

Because it can qualify under all classifications and yet be accurately described by none, but more emphatically because it is unique, Okefenokee is given a chapter by itself.

It is a matter of regret that Okefenokee could not have been set aside before its greatest stands of cypress and gum trees had been fed to the insatiable saw mills and its pine groves worked for turpentine again and again until, except for those on one small remote island, the trees are dying prematurely.

My feeling on first entering the swamp was one of disappointment. Signs of human invasion, in the form of tumbling shanties, stumps of former forest giants, rotting trestles, scattered cans and bottles, and all the familiar refuse that goes with logging and lumbering were painfully evident. Later, it was heartening

to see how after a little cleaning up, rank vegetative growth rapidly covered many of the scars left by man. Although the older pines are all doomed to die within a few years, goodly stands of sturdy seedlings are already crowding many of the islands to replace them. Young cypresses here and there—some grown into fair-sized trees since the passing of the logging crews—are to be seen, and vigorous young growth has created jungles in some of the cut-over gum swamps. Many stands of virgin timber, too small or too remote to justify the cost of logging, still remain untouched. The total amount is considerable and adds much to the value and beauty of the swamp. It is good that this weird land is to be preserved and, so far as possible, restored to its former primitive condition.

Okefenokee is marvelous. Once behind the first cypress bay one beholds a peaceful, placid landscape, which, with the reflections from the surface of the dark water, is like a hall of mirrors. All about are long thin lines of woodland swamp; clumps of cypress, hoary with the drooping streamers of old man's beard; and acres upon acres of water lilies. It is a land apart, with even a terminology of its own. Okefenokee's "prairies" are the open marshes, usually so thickly grown with lily pads that poling a boat through them is a slow and laborious work. Incidentally, the lily pads are "bonnets," while a "hammock" is an area covered by a dense growth of broad-leaved trees. The scattered groves of cypress—always gray green against the darker green of other vegetation—are "cypress bays" or "bays"; while a "boat run" is an open trail through the "bonnets," either natural or grubbed out by hard work with a potato hook, the tool used to drag the thick roots to one side. These runs follow about the same route each season and are used by the boatmen in getting about in the swamp. A "lake" in the Okefenokee is any body of clear open water. It may vary in size from an old alligator hole worked out in the lily pads, to Billy's Lake—several miles long and from one to 300 yards wide—the largest body of open water in the entire swamp.

The accepted, and often the only possible, method of travel, except by wading and wallowing, is in a light flat-bottomed boat propelled by a push pole forked at the lower end in order to get a purchase on the tangled roots in the bottoms of the prairies. Scattered through the swamp are numerous islands, large and small, some elevated enough to furnish footholds for forests of

magnolia, gum, or pine, while others are merely slightly drier parts of this damp world.

Okefenokee is quiet in the noon-day sun; only the shimmering heat waves betray motion, unless one spies a turkey buzzard or a bald eagle soaring in the sky. Apparently there is no land—just water and bonnets and the cypress bays, each faithfully reproduced in reverse in the bordering water. This mirroring creates a fantastic, unreal world with apparently nothing solid and substantial to dispel the illusion. The boatman propels the lightly built boat with rhythmic thrusts of the long pole, at the rate of about a mile per hour. Every bend in the boat run winding through the maze of islands and cypress bays, presents a vista so like the last that one must look for minor details to detect a difference. Occasionally a startled pair of wood ducks splash noisily into the air, or a "poor Joe," as goes the local designation for the angular, awkward, great blue heron, flaps away with dangling legs, ready to drop back into the water behind the first bit of tall vegetation. Perhaps an American egret is routed from his eternal frog hunting, which is good hunting indeed in Okefenokee, or a silent skein of white ibises rises from behind a cypress bay and glides on noiseless wings to a new feeding ground.

Morning and evening the swamp comes to life. The trumpeting of the Florida cranes echos and re-echos in the woodlands and the cat calls and hoots of the barred owls become a part of the chorus. These owls and the red-shouldered hawks, the one by night and the other by day, police the Okefenokee in unwonted numbers. In spring the bellowing notes of the old bull alligators furnish a background of bass for the most amazing frog choruses. Shrill voices and deep—soprano, alto, tenor and bass—join in the amphibian symphony hour. The song is endless and the supply of singers apparently inexhaustible, although I more than suspect that they furnish a large part of the daily fare for many of the predatory denizens of the swamp.

A coon's face looking up at one from the mirrored surface of Okefenokee's dark waters may startle at first but one soon learns to locate the animal itself on an overhanging limb. A sleek otter may glide silently and smoothly along ahead of the boat or a large "gator" splash noisily into the water when disturbed in its sunbathing.

In the early morning hours the liquid notes from the golden throat of the prothonotary warbler mingle with the louder ring-

ing song of the Carolina wren, the rattle of the kingfisher, the strident calls of the crested flycatcher, and the duo-toned whistle of the tufted titmouse. The simple, sweet trill of the pine-woods sparrow comes from every island and shore line where the pine and palmetto grow, and as evening falls the guttural chucklings of the chuck-will's-widow go on far into the night.

Majestic Florida cranes stalk about the prairies, often easily found if one knows where to look, but one must take Okefenokee as it presents itself. One may cross from Camp Cornelia to Floyd's Island without seeing more than a half dozen egrets and blue herons, only to find the swamp alive with these and other water birds on the return trip. With the endless floating islands and patches of rank vegetation to conceal them, many birds can be present without being detected. There may be great companies of various species—the little blue, Louisiana, great blue, and little green herons, American and snowy egrets, black-crowned night herons, white and wood ibises, and the anhinga or water-turkey. One may see all of these in a single day's travel and, again, see few indeed on another trip. These irregular heron squadrons are a part of the swamp, without which it would be imperfect, but to me the Florida crane, red-shouldered hawk, barred owl, pileated woodpecker, crested flycatcher, Florida grackle, and alligator—an odd lot to be featured against such background—are most eloquent of its varied life. These are the creatures that attract most attention. Nowhere else can one see more barred owls or the beautifully patterned red-shouldered hawks. No other single swamp has such a large breeding population of Florida cranes, while the long-tailed grackles and the crow-size, flame-crested, pileated woodpeckers are everywhere. More than eighty-five species are known as summer birds while some ninety occur in winter.

Alligators, large, medium, and small, are everywhere there is a bit of ground on which they can sun themselves. Rumor had it that the alligators were once almost extinct in the "land of the trembling earth." Be that as it may, there was evidently ample seed stock left, which under protection has started vigorously to work to repopulate the swamp. The job is on the way to accomplishment for there is a large population of small 'gators, a moderate number of the eight-footers, besides a small number of real old timers. Several that are regularly seen approach, and perhaps exceed, twelve feet.

Mention must also be made of the turtle population, exhibits of which decorate every floating log on sunny days. These range from huge snappers to the beautiful painted turtles and the leathery soft-shelled species. No chronicle of the great swamp would be complete without mention of the thick-bodied, dangerous-looking cotton-mouth moccasins and the less common diamond-back rattlers, giants of their venomous clan, which are occasionally found on the islands. The former are everywhere in the swamp, but fortunately are so sluggish that "accidents" are of rare occurrence.

Tracks of bears, raccoons, wildcats, and deer are everywhere, even though the animals themselves are more successful than their bird neighbors in keeping out of sight. The teeming life of Okefenokee makes it one of the outstanding wildlife areas of the land.

Physically Okefenokee is a vast boggy saucer perched on the height of land that separates the Atlantic waters from those that flow into the Gulf of Mexico. St. Mary's River rises in this shallow basin and flows by an exceedingly devious course into the Atlantic, forming, in its course to the sea, part of the boundary between Georgia and Florida. Out of the western side of the Suwannee gathers its dark waters and carries them into the Gulf. The swamp itself is a shallow basin with a hard bottom but filled with the mucky debris of countless generations of plants. Its reputed "sink holes" are non-existent, or at least exist only in stories. General Floyd's army, bent on punishing raiding Seminoles, wallowed across the swamp in its campaign of 1838. The representatives of the Hebard Lumber Company did the same thing seventy-five years later when they cruised the timber and laid plans for logging which began about 1909 and continued until the federal purchase in 1937, although the major operations were over some years prior to that time. Neither found any sink holes.

The town that stood on "Billy's Island" and once boasted six hundred inhabitants and a motion-picture show is now only a memory. The island and adjoining Billy's Lake have been given back to the wheeling eagles and ospreys and the gangling fishermen of the heron clans. Vanished, too, are most of the railroad trestles that threaded the swamp, and the screeching locomotives that hauled the cypress logs to the mills.

A more lasting scar on Okefenokee's primitive landscape is the great canal that was cut some twelve miles into its heart

from the east. The objective of this ditch was to drain the swamp into the St. Mary's River. Fortunately this enterprise failed but it left a canal useful as a highway into the swamp for visitors and patrolmen alike. It did no permanent harm, and the muddy piles of earth left on either side have long been overgrown with swamp vegetation or have subsided beneath the waters.

This canal, together with the lakes, be they big waters or small alligator holes, furnish the fishing for which the area is locally famous. Huge large-mouth bass, "green trout" in Okefenokee parlance, and pickerel, called here "jacks" are the principal game species. Smaller pan-fish are also present, a fact thoroughly appreciated by local residents and visitors alike, who in 1940 took 33,367 fishes from these waters under the free daily fishing permit system.

The fact that only a small proportion of the waters is open enough for fishing would seem to be a perpetual guarantee that Okefenokee will never be "fished out." That could be counted upon except for the swamp's trick of going nearly or completely dry during drought seasons. There is no great depth of water and the swamp is largely, if not wholly, dependent on the rainfall that reaches its own surface for maintenance of its water level. The great mass of decaying vegetation acts as a huge sponge taking up the water and yielding it to the slow pull of gravity through the river outlets and somewhat faster to the more insistent urge of the hot summer sun. During drought seasons the swamp may become dry enough to burn, as it did when the disastrous fire of 1932 swept a large portion. The same conditions prevailed in 1940 and might have had an equally serious result if it had not been for the constant vigilance of the patrolmen, aided by a few fire breaks cut by the Civilian Conservation Corps. During such dry seasons the fishes and amphibians alike are seriously reduced and one or more successful breeding seasons at normal water levels are necessary to replenish their numbers. There is some evidence to link variations in the summer population of herons to the fluctuations in the abundance of swamp life occasioned by droughts.

PLANS AND PROGRAMS FOR THE SWAMP

It is emphatically the desire of the Service to retain Okefenokee's primitive character and so far as possible to allow its restora-

tion to the conditions that existed prior to 1909. Many years must pass before the greater cypress bays are again filled with swamp monarchs such as formerly existed. The pines and gums with their associated trees will come back faster but it will take long years to refill completely suitable parts of the swamp with their growths. Not that the cypress is gone—far from it. There are many small virgin groves that were never touched and numerous stands of trees that were too small to cut profitably at the time of logging, which in the intervening years have grown into fine bays.

Every plant and animal that was once in the swamp is still there, with the possible exceptions of the panther and the ivory-billed woodpecker. Panther tracks are occasionally reported in or near the swamp and it is possible that a few of these animals still exist in its more remote sections. Ivory-billed woodpeckers formerly existed here and hope will not die that some individuals may still remain. In fact there is recent evidence that at least one bird does still live. Those most familiar with the vastness of the Okefenokee believe that a number of these great woodpeckers might exist and be easily overlooked. Travel is slow, the area is large, and the field of vision limited—three factors that make thorough checking for individual birds almost impossible. The cypress bays are in many cases impenetrable except by wading and wallowing through and over the cypress roots—a process not exactly compatible with continuous and careful observation. Every patrolman keeps a lookout for this bird, so much like and yet so decidedly unlike the common "wood kate," or pileated woodpecker, which otherwise is boss carpenter of the swamp.

Patrol is a dominant feature of the management of the Okefenokee—one made doubly necessary by the fact that the swamp has long been a hunting ground for many of those living near its borders. The majority of the people have been most coöperative but the usual small proportion of violators remains.

No roads will be built within the swamp and travel will be confined to the canal and runs, by push boats in some areas and by small boats with outboard motors in others. Headquarters for control of travel into the swamp have been selected but only one has as yet been established—at Camp Cornelia near Folkston. Eventually there will be a second on the western side of the swamp near the foot of Billy's Lake, and a third at the north end on Cow House Island.

It is felt that the swamp vegetation will completely restore itself, providing fire can be kept out. In this connection the extremely dry years, which render some of the largest prairies powder-dry, bring the greatest hazards. Consideration has been given to placing a sill in the outlet of the swamp through the Suwannee for the purpose of slowing up the run-off and retarding drainage during droughts. This undoubtedly would reduce the fire hazard, but there is no present assurance that it can be done. Such a sill would not raise the normal water level as, in periods of heavy rain, run-off occurs in all directions. In low water stages, however, it passes out only through the Suwannee River, giving opportunity of preventing the extremely low stage.

Another management project is restoration of the stands of pine on the logged-off islands. Some of these are being seeded naturally; others, remote from seed trees, will need to be planted. A limited amount of this reforestation has already been carried out.

STORIES OF OKEFENOKEE

Many stories have been woven about the great swamp. The most popular is "Swamp Water," which has appeared both in book and on the motion-picture screen. Endless stories of great hunting and trapping and fishing in its vastness circulate locally. While many of them are doubtless exaggerated, there can be little doubt that great quantities of game, fur, and alligator hides have been taken.

Ducks at one time frequented the Okefenokee in far greater numbers than in recent years. The rather mediocre quality and quantity of food available makes one suspect it was necessity rather than choice that sent these representatives of a vastly greater continental population of ducks here. It is a fair assumption, therefore, that as the continental waterfowl populations increase Okefenokee will be utilized increasingly as it was in the past.

While some of the local stories deal with ducks, the great majority take the exploits of bear, deer, and alligator hunters for their themes. They run the usual gamut of such tales and none that I have happened to hear had enough originality to commend its repetition.

Accounts of remarkable catches of otters, wildcats, raccoons, and opossums have also come out of the swamp, many doubtless

with much truth in them. In the years immediately preceding federal acquisition of the refuge, however, the game and fur was depleted much below its former abundance, a fact that may in some degree account for the ready public acceptance of the refuge.

CHAPTER XI

Patuxent Wildlife Research Refuge

At some future time June 3, 1939 may be recognized as a red-letter day in the American wildlife conservation movement. On that date a long-cherished dream of a few devoted workers came true when Secretary of Agriculture Henry A. Wallace dedicated the Patuxent Wildlife Research Refuge. This unique institution, the world's first national wildlife research station, adequately equipped with laboratories and lands for both indoor and outdoor studies was actually an established and going concern.

To achieve this reality, much arduous work had already been done and many difficulties surmounted. It is so easy to write that it happened but these brief words convey nothing of the efforts put forth to produce the result. At least as far back as 1915 some members of the Service were talking of the desirability of establishing research laboratories on lands suitable for out-of-door work. Senator Harry Hawes once introduced a bill for the purpose, but it never became a law.

The first actual step toward realization of the plan came in 1934 when Jay N. Darling, then Chief of the Survey, obtained the promise of a tract of Resettlement Administration land adjoining the Beltsville Agricultural Research Center. The first unit offered was not satisfactory as it lacked water, but a fortunate combination of circumstances later permitted the selection of the present area embracing from three to four miles of the Patuxent River.

The Resettlement Administration not only permitted the Biological Survey to occupy the land in May 1935 but provided funds to purchase material and employ labor to construct an eight-foot woven-wire boundary fence. Some thirteen miles of fencing were installed but no attempt was made to build along the river which at that time formed one boundary. The annual floods that spread over this valley made it advisable to buy land across the stream to obtain a higher site for the fence. The fencing was nearly completed when the defense program and the resulting rush of work at adjoining Fort Meade absorbed all available labor.

Hence, some additional fencing remains to be done before full protection of the area can be achieved.

Standing on the most prominent point of a ridge that faces the Patuxent River and forms the backbone of the refuge, Snowden Hall, a locally historic, brick, colonial mansion, furnished the motif for the architecture of additional buildings. Money allotted from various emergency funds became available during the next three years and three laboratories, a green house, machine shop, garage, and residence accommodations for ten families were provided. At the same time Snowden Hall was repaired, equipped with heat and water and became a combination dormitory and cafeteria to serve the personnel stationed at Patuxent and those brought in on special details or for in-service training.

During the construction phase, services and funds of the Civilian Conservation Corps, Works Progress Administration, and Public Works Administration contributed to the development. Water and sewage systems and service roads and trails were installed; holding pens, for use in studies of nutrition and diseases of wild animals, were built, and numerous other projects completed. All were designed for the basic purpose of facilitating wildlife research.

Obviously, all wildlife problems cannot be solved by studies at a single locality. The wide diversity of climatic and vegetative conditions, to say nothing of the differences in mammals and birds themselves, would prevent such an accomplishment. The guiding thought has been that this station, devoted primarily to research by a diversified group of specialists, could be so directed as to become increasingly valuable as a standard by which experiments and studies elsewhere might be measured.

Thus, results of certain investigations at the Rothamsted Agricultural Station in England have become the basis of comparison for fertilizer and fertility tests over the world. The history of plots of ground there, going back for many years, have proved exceedingly valuable as a check on experiments in far-away lands. So Patuxent, as the years go by, should gradually acquire a similar value in relation to wildlife research. To that end a long-time program of basic investigation has been adopted, which it is hoped will not only yield many practical results but also produce a careful record of the effects on wildlife of various management practices. The advantage of having together the workers, the tools, and the wildlife and the land on which it lives is very great.

An accurate topographic survey and a large-scale type map of the land was made and the entire area covered with a grid system with permanent markers at all corners of each 2½-acre tract. A base land-use map has been prepared. The plant growth of the refuge was carefully surveyed and a report upon it published. A 65-acre lake, known as Cash Lake, was developed. Here all timber was cut and the stumps removed prior to flooding. A detailed history of the chemical and physical changes that take place in this body of water is kept as a background of accurate information for the guidance of future studies. A second lake, of quite different depth and shore-line contours, was planned and the ground cleared. However, completion of the dam must await better times. Other impoundments of different types, all valuable for the research work planned here, will be made when funds and labor are again available.

The refuge land is as ideal for the purpose as can be found within a hundred miles of Washington. It lies in an asymmetrical rough crescent with the larger horn lying along the course of and including some three miles of the Patuxent River while the shorter end includes a spring-fed creek which furnishes the water for Cash Lake and the partially constructed Lake Redington. In bottomland of the Patuxent, as well as of its smaller tributary, are good stands of timber, which include tulip, ash, elm, red maple, beech, swamp white oak, sycamore and river birch in abundance, as well as other trees and shrubs. Some of the trees are ancient specimens, the largest being a swamp white oak with the trunk six feet in diameter. Much of this forest is over mature and falling into decay, but it is typical of aged river-bottom timber. The benchlands and gently rolling hills that form the upland part of the refuge are well diversified as to cover types, an important requisite on any wildlife area and especially valuable on these lands to be used for experimental purposes. There are pure stands of Virginia pine of different ages up to those large enough to furnish a complete canopy and shade out all plants save a few that thrive in a combination of dense permanent shade and a thick carpet of pine needles. In two of these pine groves are fine colonies of the stemless ladyslipper (*Cypripedium acaule*).

There is one especially fine beech grove and several hundred acres of other upland hardwoods, 70 per cent of which is a mixture of several species of oaks. There are open fields, some of which were in cultivation at the time of acquisition. These fields

PLATE 17

THE NATIONAL ELK REFUGE IN JACKSON HOLE, WYOMING, FURNISHES WINTER FOOD FOR AMERICA'S LARGEST ELK HERD

Upper. Hay is provided for emergencies.

Fish and Wildlife Service photograph by O. J. Murie

Lower. When winters are bad and food is scant, as many as 9000 animals are congregated here.

Fish and Wildlife Service photograph by A. P. Nelson

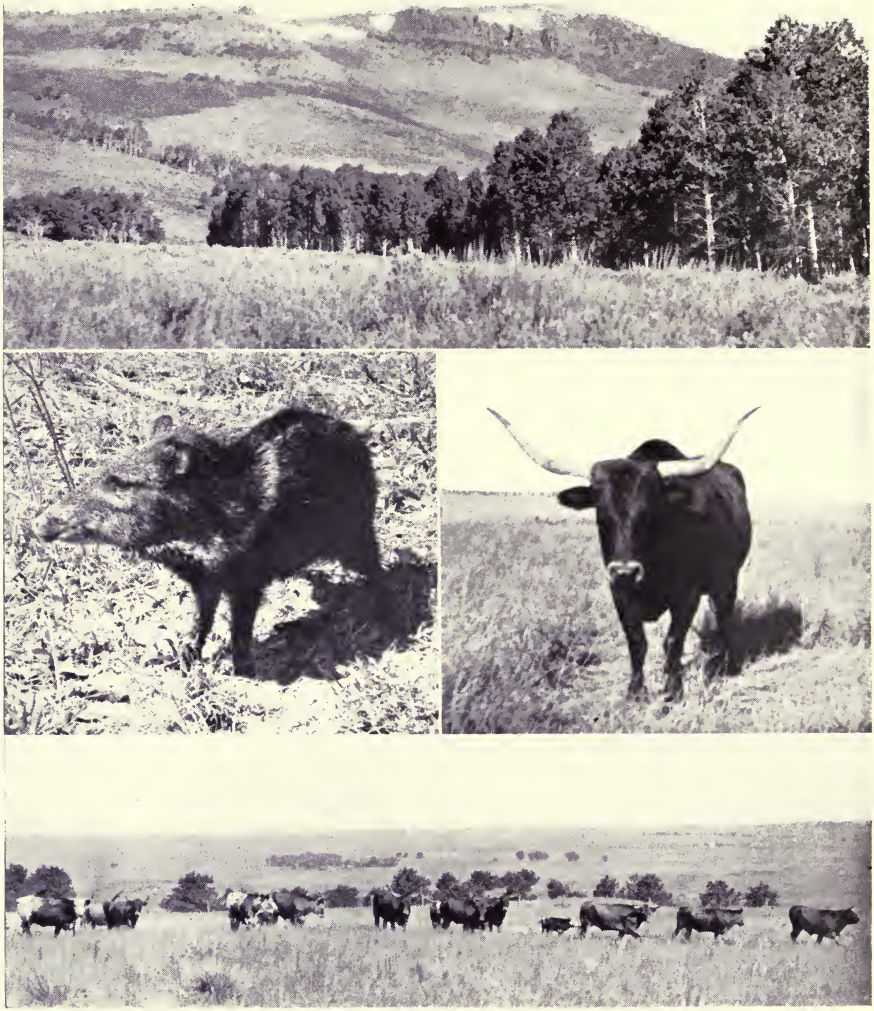

PLATE 18

UPLAND GAME REFUGES ARE AN IMPORTANT PART OF THE GENERAL PROGRAM

Upper. Hart Mountain National Antelope Refuge offers protection to more than a hundred species of wildlife in addition to the antelope.

Fish and Wildlife Service photograph by Stanley G. Jewett

Center left. The peccary as yet has no refuge ideally suited to its preservation, but a small herd lives on the Aransas National Wildlife Refuge.

Fish and Wildlife Service photograph by Earl Craven

Center right. Texas longhorn steer at Fort Niobrara.

Fish and Wildlife Service photograph by Geno Amundsen.

Lower. Two small herds of longhorns are kept on wildlife refuges.

Fish and Wildlife Service photograph by Geno Amundsen

are of low fertility but even so are useful for experimental purposes. Many are bordered by thick hedges of bird-planted berry- and fruit-producing trees and shrubs. Other slopes and benches, once cultivated fields, are being naturally reforested with almost pure stands of alder, juniper, locust and sweet gum. Others are developing a mixed growth of trees and shrubs. Some areas are still in dense broom sedge, the first stage of recovery after cultivation is stopped. This, plus the first shrub invaders, provides a transitory stage that should always be represented because of the preference shown for it by the Henslow's sparrow, a bird little known to the general public but abundant here.

The diversity of conditions on this abandoned farmland is favorable for wildlife experiments and, so far as practicable, it will be so maintained. This does not mean that any one field will be necessarily kept in the same condition but that the area will be so handled that the same whole range of environments will continue to exist on the refuge. A definite record will be kept of changes in vegetation and wildlife populations that occur naturally or that may be induced by experimental handling.

One of the great difficulties in carrying on such long-time projects has been lack of control of the facilities by the research staff. Administration, thoughtlessly or ignorantly, has on occasion upset years of study and recording by abrupt changes in policies. Hence, this area, while serving as a refuge incidentally, is actually in control of the biological research staff and is in fact a place where long-time research projects may be confidently planned and carried out.

It has taken time to develop plans and several years will be required to establish the desired practices. First decisions had to be reached on general objectives; then areas were selected for various experimental projects or for cultivation in the planned-management cycle. Plot units will artificially be thrown into certain phases of ecological succession by such methods as planting to perennial herbs, trees or shrubs, clearing or partial clearing, selective cutting and other management practices.

A fine population of small non-game birds and mammals was present at the time of acquisition, the great diversity of conditions attracting a variety of life that adds much to the value of the refuge for study purposes.

Game species, sadly depleted in 1936, have increased in a very satisfactory way. Bob-whites, woodcocks, mourning doves,

opossums, raccoons, cottontails and gray squirrels are now present in numbers sufficient for experimental work, and turkeys, ruffed grouse, and white-tailed deer, once indigenous, will be introduced when developments warrant. Red and gray foxes also are plentiful and wildcats have shown themselves. There is ample opportunity for utilizing these species for study and homes are available for various other animals if required.

The master management plan was finally approved on May 23, 1941 and future developments will be in accordance with it. The various studies will be initiated as rapidly as available money and man power permit. The plan is here presented in brief since, better than any amount of explanation, it will convey an idea of the scope of work.

OBJECTIVES

The objectives of wildlife research planned for the Patuxent Research Refuge are through laboratory and field investigations: (1) to learn optimum conditions for wildlife production; (2) to solve problems in land management; (3) to test (and demonstrate the best) practices known to favor desirable wildlife species; (4) to test the methods of wildlife utilization and their effects on populations; and (5) to carry on laboratory experiments relating to nutrition, food habits, diseases, and parasites of wildlife.

Long-time projects designed to accomplish these purposes will include:

1. Deliberate changes in food and cover, with careful measurements of their effects upon wildlife use.
2. Practical wildlife management as a priority in land use, correlated with the economics of wildlife production.
3. Practices favorable to wildlife as a by-product of normal forestry and agricultural operations.
4. Harmful or beneficial effects of wildlife on forestry and agriculture.
5. The degree of diversification of crop and forest lands in relation to wildlife needs and techniques necessary for securing it.
6. Factors limiting populations of wildlife species, with emphasis on game and fur animals.
7. Life histories and habits of all wild species living on the refuge.
8. Wildlife utilization methods and their effects on populations.

9. Interrelationships of wildlife species.
10. Practical methods of producing wildlife in confinement.

Research Planning

Surveys will show: (1) the location of lands recently in agricultural crops; (2) the areas now devoted to forests; (3) waste lands not fit for agriculture; (4) permanent field borders and fence rows; (5) ponds, lakes and streams; and (6) areas zoned for headquarters buildings and grounds, farm buildings, roadways, power lines, gravel pits, test-animal pens, and quail-production units.

Wildlife in Relation to Agriculture and Forestry

The objectives for agriculture provide for: (1) studies of farm crop diversification and harvesting according to wildlife needs; (2) utilization of crop lands by wildlife as a normal by-product of agriculture; (3) economic use of hedge rows and field borders, with plantings of value to the farmer; (4) the harmful or beneficial effects of wildlife on agriculture; (5) the effects of wildlife utilization on agricultural income, on sustaining wildlife populations and on destruction of property; and (6) the practicability of food strips for winter feeding.

The objectives for forestry provide for determining: (1) the best proportion of farmlands to woodlots for optimum wildlife use, and their most practical size and shape (2) the effects of forestry practices upon wildlife; (3) the effects of wildlife on composition, distribution and density of woodlands; and (4) the use made of trees and shrubs by wildlife for seasonal food and shelter.

THE PROGRAM IN ACTION

Translated into action on the ground, this program is taking shape in the establishment of a farm unit in which the usual local crops will be grown. Good agricultural practices will be followed in order to build up the soil and prevent further destructive erosion. They will include fertilization and crop rotation and the introduction where needed of contour plowing, strip cropping, terracing and gully control. At the same time practices that are recommended to maintain and distribute wildlife will be introduced. Eventually this program will result in

development of a farm unit that will provide feed for all animals reared in confinement on the refuge. It will serve both as a testing ground for wildlife-management practices and a demonstration of the value of those that prove themselves.

The program also includes cutting openings of various sizes and shapes in the available types of woodland. It has long been known that wildlife populations are greater along forest edges. Little specific information exists on the reasons for this effect and it is hoped to measure the influence of shape and size of forest openings and to get some measure of the response of wildlife populations to them. Such information would indicate the extent to which game management of forestlands may properly be carried. The general belief now is that very little cost per acre is justified by the possible financial returns from game management, but accurate knowledge on the point would be more satisfactory.

The disease laboratory at Patuxent will be the center of wildlife-disease studies carried on by the Fish and Wildlife Service. This was, until recently, an almost untouched field and one in which knowledge is badly needed.

Thoughtless people often say: "What's the use of studying diseases of wild animals anyway? Even if we know what's wrong we can't catch them and give them a dose of medicine." It may be true in some cases that nothing can be quickly accomplished, but just one example served to convince me of the practical value of disease investigations. That was the mysterious duck sickness that killed many thousands of ducks in the western states. It had been learned that giving fresh water and uncontaminated food would cure a high percentage of the stricken birds. "Duck hospitals," maintained at a few of the worst localities and consisting essentially of pens provided with an abundance of fresh water, returned to the flyways thousands of cured birds that otherwise would have perished. We made little progress in controlling the malady, however, until Kalmbach found the cause to be a toxin produced by botulinus bacteria. Since then various preventive measures have been developed, which if applied in time will often materially reduce the losses. Control of water level is effective when properly used. Mechanical agitation of the waters is under some conditions effective in stopping outbreaks altogether or lowering the losses occasioned by them. Some plants are more, others less, favorable to production of the toxin. Thus wise choice

of planting stock and manipulation of water levels to favor certain plants over others are obviously desirable management practices. Many aquatic plants are exceedingly susceptible to changing water levels and it is often possible to alter radically the plant composition of a marsh in a season or two. Unfortunately control of water levels cannot always be achieved, but in an increasing number of the most critical areas either federal or state governments have adopted programs that have materially reduced losses.

It is not implied that all problems concerning the so-called western duck sickness have been solved. There are still marshes where outbreaks occur that have not yet proved susceptible of control. However, it is certain that practical attack on the disease by preventive or remedial changes in the physical conditions producing the outbreaks would never have been possible if the character and cause of the disease had remained unknown. We first had to identify the enemy and learn its weaknesses before a successful attack could be devised.

Additional investigations of the botulinus organism are among the studies going on at the Patuxent Research Refuge and in a traveling field laboratory as well. This work has already contributed information useful in the battle against botulism.

Similar studies on the diseases that affect fur and big-game animals and upland game birds are being carried on and in some cases encouraging progress has been made.

Such research should ultimately cover three phases: (1) the effect of the disease on the wildlife species; (2) its effect on domestic stock if transmissible; and (3) any possible direct relation to man. Certain animal-borne diseases also affecting man are becoming increasingly important and it is fortunate that the Service is better equipped than ever before to aid in their study and control.

In addition to this personnel, other biologists are at the Patuxent either permanently or on special assignment. In a number of cases state game commissions have sent employees to take advantage of the facilities and equipment although it has been only a little more than a year since it became possible to furnish such accommodations. The state agencies find it much less expensive to send their men to this institution than partially to duplicate its facilities, and it is expected that this type of coöperation will increase.

The Fish and Wildlife Service also uses the facilities of the

refuge for training its own new research biologists and also often finds it less expensive to detail them to Patuxent for a few weeks than to purchase additional equipment.

Three in-service training schools for younger members of the Service have been held at the Patuxent during the past year. These have been short courses designed to afford the newer men an insight into Service programs and policies, to give them the benefit and guidance experience with older employees, and also training in the newest methods of wildlife administration and management.

Accomplishments to date are perhaps of no great consequence in themselves, for in planning such new departures it is a common human failing to "dream too small." However, at least the foundations have been laid for a national wildlife center which, barring unforeseen occurrences, should furnish increasingly accurate data on which to base a better and wiser administration of our wildlife resources.

CHAPTER XII

Migratory Waterfowl Refuges

Public attention has been so largely directed toward the conservation of waterfowl that the average citizen thinks of the national wildlife refuge system as exclusively for the benefit of those birds. The facts are, however, that establishment of a special refuge preceded that of the first one for waterfowl by five years, and legislation creating the National Bison Range was passed some months before the first migratory waterfowl sanctuary was set aside by Executive Order at Lower Klamath Lake on August 8, 1908.

There are various reasons for this impression. Since the passage of the Migratory Bird Treaty Act in 1918, the public has assumed that migratory waterfowl were the responsibility solely of the federal government. This is an erroneous idea as the states are, or should be, greatly concerned with the welfare of these birds. Then, too, the great decline in numbers of waterfowl between 1925 and 1935 focused attention upon them. Also, marsh restoration for the benefit of waterfowl has been the most spectacular part of the refuge movement. There is something especially appealing to the American mind in a vast "constructive" program, even though required merely to offset previous human destruction.

The federal waterfowl refuge program started in 1908. Reservation of Lower Klamath Lake in California and Oregon, and Malheur Lake in Oregon, was the direct result of the activities of William L. Finley and a small group associated with him. These two outstandingly valuable areas were made refuges but both were destined to be destroyed before conservation sentiment became strong enough to protect them. Both were recovered under the restoration program that came with the national effort of 1930–1940.

While a number of additional refuges, mostly on reclamation reservoirs and sumps, were created in the interval, the real basis for a national system of waterfowl refuges was established when

President Coolidge signed the Migratory Bird Conservation Act, also known as the Norbeck-Andresen Act, on February 18, 1929. This provided a comprehensive legislative basis and authorized the appropriation of funds to purchase and develop lands for the conservation of waterfowl. Though this legislation was an important achievement, it had little immediate effect, as the depression which began in 1929 prevented appropriation of the money authorized.

However, many events between 1908 and 1929 forecast future action. In 1915 Service biologists were engaged in studies of the vanishing waterfowl habitat of the Great Plains. While these studies did not result in saving the marshes, they provided information that was most valuable when restoration was undertaken.

The devastating combination of drainage, drought, and overshooting, long before recognized by careful students, became increasingly ominous during the 1920's. The total of lands drained in the United States and southern Canada was approaching 100,000,000 acres, the drought period which began to develop about 1915 became more severe and spread over more territory, and the increasing army of gunners with better weapons and transportation, intensified the pressure upon the waterfowl.

Dwindling of marshes forced the surviving birds into constantly smaller areas making them more accessible to the hunters. Worse, the great concentrations in remaining waters created the false impression that the birds were as abundant as ever and strengthened resistance to conservation measures. There are individuals even today, fortunately situated near concentration areas, who deny that there ever was any decrease in the waterfowl. They saw only the favored spots and failed to realize that the birds had vanished from many previously valuable areas. Any one of the major factors mentioned—drought, drainage or overshooting—alone could have caused a decline in waterfowl population. In combination their effect was catastrophic.

The remedy was simple in conception, difficult in execution. In the early 1920's prophetic voices, both inside and out of the Biological Survey, emphasized the crisis threatening the waterfowl. Yet the public understanding of the danger was not widespread enough nor conservation forces powerful enough to bring remedial action. Paul G. Redington, Chief of the Survey (1927–1934), with his three R's—refuges, research and regulation—was

right in his analysis of the situation but he failed to get sufficient support to correct it. During his administration, however, the Migratory Bird Conservation Bill was passed and money authorized for the purchase of refuges, thus laying the foundations for the accomplishments of coming years. This was the first allocation of federal funds in support of a general refuge program, although the Upper Mississippi River Refuge Act (1924) and the Bear River Migratory Bird Refuge Act (1928) had specifically provided funds for these great refuges.

A start had been made but it was not until the intensified droughts of the 1930's convinced all but the most unenlightened gunners of the seriousness of the situation that pressure became great enough to force adequate action. Fortunately at that time the right leadership became available and the dynamic personality of "Ding" Darling became the rallying point of the forces of conservation.

He craved action and got it. A program—simple but effective—was laid out, money obtained, and the work started. Few believed that it would succeed. Many conservation leaders, weary of the long years of apparently futile battling, thought that it was too late and that the waterfowl were doomed. They believed, and all previous experience indicated the correctness of their view, that funds and public support great enough for the gigantic task could not be obtained. But the miracle happened, and both funds and public support were forthcoming in an abundance for which there was no precedent.

The decline of the waterfowl stopped and, slowly at first and then faster, the continental population began the long slow climb to regain its former abundance. As this is written, in the spring of 1942, the evidence indicates that the population of waterfowl is now nearing the goal dreamed of in those dark days of 1934 and 1935. However, it is not safe to rest on present achievements. The voices of the game hogs, long almost silent, are again being raised with demands for the restoration of all the killing practices that were among the causes of the waterfowl's decimation.

Perhaps this conservation battle will yet be lost, although its lesson should have been fixed in our memories. The success of the present program has demonstrated its soundness and we have only to hold to its proven tenets to be on safe ground.

The program has had two aims: to hold the human harvest and losses from all other causes to less than the crop produced

each year, and to restore suitable environment on a *continental* scale.

The Migratory Bird Convention between Great Britain and the United States, signed August 16, 1916, and a similar treaty with Mexico, signed February 7, 1936 in Mexico City and finally ratified and proclaimed on March 15, 1937, provide a solid basis for continent-wide handling of migratory-waterfowl conservation.

Drastic reduction of the kill was in the earlier years the most important factor in preserving breeding stocks to occupy existing but underpopulated breeding grounds as well as the restored marshes. This restriction is still, and always will be, an important factor in maintaining the waterfowl population. Only so long as we regulate the kill according to the crop produced can we believe that we are managing the waterfowl on a rational basis.

The restoration of marshes, which at first had little effect, has vastly grown in importance as more areas have been reflooded and as the quality and quantity of food produced has increased. It requires time for suitable aquatic life, both plant and animal, to become established. Nevertheless, the new marshes are contributing increasingly to the welfare of waterfowl.

In the refuge program emphasis was first placed on the restoration of breeding grounds. Most of the famous Great Plains marshes in this country and in southern Canada were going or gone. The public at last took the years of drought seriously and money was poured into prairie states to meet the emergency. Some of it was given to the Wildlife Service for marsh restoration and the first surge of this work was started in 1934.

This early and quite proper emphasis on restoration of breeding grounds tended to obscure other waterfowl needs. Some still ask, "Don't you think the restoration of breeding grounds is most important?" This question may well be answered with the Yankee trick of another question, "Which is more important to you, that you eat in summer or in winter?"

The point seems obvious. A glance at the accompanying maps reveals clearly that the major breeding grounds of waterfowl are in Canada and Alaska. It indicates with equal clarity that the chief wintering habitat is in the United States and Mexico. Study of the maps will further show that a population of waterfowl spread out over more than half of the continent in the breeding season is concentrated in a comparatively small territory during the winter months. Beginning about December first, when the

migration is largely completed, and the birds are settled in their winter quarters, the entire continental population is restricted to the smallest area occupied at any season. It is then most vulnerable to overshooting, to storm and cold, and to shortage of food.

The thin fringe of marsh, extending from Long Island south along the Atlantic, the Gulf coastal marshes in both this country and Mexico, those of the lower Mississippi Valley, and the scattered concentration areas in Mexico and the western states, are of vital importance to the waterfowl. Indeed, it might be argued that acre for acre these wintering areas are more important than the breeding grounds because they are so much more limited. Be that as it may, the birds must eat and have suitable living conditions at all seasons. If no wintering grounds were available, restoration of the breeding grounds would be a futile expense, and the converse is equally true.

It should be further emphasized that the destruction of marshlands by drainage and drought has not affected all species of waterfowl alike and that restoration of any one type or group of marshes will not help all of the birds. Only a wise selection of projects can assure that.

There is one group of waterfowl, the breeding grounds of which are still as unaffected by drought, drainage or human interference as they were a hundred or a thousand years ago. This includes all of the geese (the Canada goose a partial exception), the whistling swan, and such ducks as the old-squaw, scoters, harlequin, and to a large extent the eiders and golden-eyes. Any diminution in their numbers must be laid to overshooting, in some instances to oil pollution, or to destruction of resting or wintering quarters. Consequently any help that marsh restoration can render them will be in providing better food and cover in migration and during the winter months. Many of the refuge units in southern Canada and northern United States that we class as breeding grounds serve as important way stations for these more northern breeding birds.

Another considerable group of waterfowl have such extensive breeding ranges that they have not felt so severely the adverse effect of drought and drainage, except by limiting food and water available to them while in migration and during the winter. The most important of these are the mallard, pintail, baldpate, green-winged teal and scaups. These birds will profit moderately by breeding-ground restoration and more by the improvement of

wintering grounds and resting places on the migration routes. Many of the restored breeding grounds will be of value to northern nesting individuals in migration, while serving more southern representatives of the species as nesting quarters.

Species breeding farthest to the south (in the plains waterfowl territory) were affected most by drought and drainage, and consequently were in greatest need of assistance. Of these the redhead, canvas-back, ruddy duck, gadwall, and the cinnamon and blue-winged teals were most important. The shoveller or spoonbill, although having a somewhat greater range, was also badly affected. This group, the hardest hit of all, went farthest down the road to extermination, and has been the slowest to respond to restorative measures. Formerly 50 per cent or more of the breeding grounds of the redhead, teals, gadwall and ruddy were in the drought-stricken and drainage-cursed northern Great Plains. These birds should benefit most from marsh restoration because, with the exception of the two teals, which winter largely south of our borders, their breeding grounds, migration routes, and winter quarters lie largely within the area in which restoration work is proceeding.

The areas that have been set aside for the benefit of waterfowl include breeding, flyway, and wintering, refuges. It is impossible to mention each of the 178 areas now in the system but the more important will be considered, excepting those on reclamation projects and on lands of the Tennessee Valley and similar agencies. Because of the special features involved in their establishment and management, these will be separately discussed.

BREEDING REFUGES

These are located in the northern states, the most important lying between the Cascade Mountains of Oregon and Washington and the Great Lakes. Within this teritory it has been the policy to restore every possible acre of marsh since all have value not only as breeding grounds but also as flyway resting places and feeding refuges for the hosts of birds that breed to the north. This discussion will be confined to restoration within the United States; that in Canada is discussed in another chapter.

The great drainage craze left intact few major breeding grounds in the United States and those that now exist are largely restored areas. It is not meant that for a period no birds bred in

this country, as even at the lowest ebb in migratory waterfowl, many were produced in small marshes and lakes, in river bottoms, and along the ever-expanding network of irrigation ditches. But marshes big enough to attract the attention of drainage promoters, together with many of the smaller units were a thing of the past. Some were permanently destroyed; others, found to be poor or useless for agricultural purposes, were abandoned and thus made available for restoration.

Seney National Wildlife Refuge. Beginning in the East we may well start with the Seney marshes in northern Michigan. Here cheap land, whose agricultural value had fallen far short of the promises of the drainage promoters, and an abundance of water were available. Because of soil conditions, some doubt existed as to the wisdom of the project, but a start was made on a small scale with dikes and control structures designed to flood the land to proper depths. Long before completion, the ducks began to use the first units and so convincingly demonstrated their value that a greatly expanded project is being developed. A refuge of 84,454 acres is in the making, 40–50 per cent of which will be flooded. Black ducks are the principal breeding game birds, but mallards, pintails, ruddies, blue-winged teals and ring-necked ducks also nest. Not the least of the attractions of this great checkerboard of timber and marsh is a breeding colony of sonorous-voiced sandhill cranes, the farthest east colony on a federal refuge. Canada geese have also been colonized here. Some 300 pinioned birds were placed within an enclosure but their descendants are free to come and go, and several hundred birds per year are now contributed to the flight.

Seney has other values than as a home for waterfowl. The open land on its western and northern edges harbor prairie chickens, while in suitable cover spruce grouse and ruffed grouse also nest. Wintering flocks of sharp-tailed grouse add a fourth species to a grouse ensemble of which few refuges can boast. A limited number of moose, some black bears, and an abundance of white-tailed deer, beavers, and muskrats also add interest and value.

When completed, this refuge will consist of a series of shallow pools lying on either side of the Driggs River (the source of the water supply), and between them open lands, resulting from old burns now thinly grown with aspen and spruce. The diversity of cover attracts a variety of small bird life.

Necedah National Wildlife Refuge (37,038 acres) lying in central Wisconsin will be an important waterfowl breeding unit when development is completed. One of the two flooding projects has been finished but a second and larger one remains to be built. This is one of the refuges set aside from Resettlement Administration purchases and in addition to shelter for waterfowl has excellent habitat for deer and ruffed grouse, and contains prairie lands very suitable for the prairie chicken which is present in some numbers.

Rice Lake National Wildlife Refuge lies to the westward in north-central Minnesota. It is one of the more scenic of the midwestern refuges. Glacial ridges, covered with spruce, aspen and birch, separate Rice Lake and the smaller lakes, all of which are favorite haunts for waterfowl. Like various other refuge sites, this was chosen because the topography and water supply made it possible to increase greatly the areas of productive marsh. Some of this development has been completed but much remains to be done before maximum productivity is attained. Rice Lake annually supports a fine stand of wild rice, the produce of which is usually largely harvested by blackbirds before the grain is ripe enough to fall. This renders the rice much less valuable as a duck food than is popularly believed. The mallard, black duck and blue-winged teal are the most numerous breeding species, but an astonishing variety of waterfowl frequent this 11,385-acre refuge. The fact that it includes a marsh, a marshy lake largely occupied by wild rice, and a number of sheltered woodland lakes makes it attractive to various types of wildfowl. Its value to the birds increases steadily as development proceeds.

Tamarac National Wildlife Refuge, also in Minnesota, is a breeding ground of a different sort. It consists of a chain of lakes and marshes on the headwaters of the Ottertail River. In years of plentiful rainfall, conditions remain good, but dry summers bring receding water lines and loss of duck foods. It is proposed to stabilize the water levels by a series of dams at natural outlets of the lakes. This refuge contains, or will contain when acquisition is completed, eight large and some thirty smaller lakes in a glacial country that is largely wooded, except for the lakes and marshes. In its vicinity are hundreds of lakes, as thickly clustered as in any other part of Minnesota.

Many species of ducks nest here, but blue- and green-winged teals, mallards and wood ducks are most abundant. At times great

concentrations of migrating birds occur. Not only do ducks take advantage of the protection furnished but whistling swans and several species of geese are regular visitors.

As an interesting sidelight on the possibilities of building up bird populations, the purple martin colony about the headquarters may be cited. Numerous martin houses, built by the Civilian Conservation Corps, have been erected in the yard and adjoining meadows. Each has been promptly occupied by the martins until the entire colony now includes hundreds of pairs. The circling, chattering martins that fill the air prevent the usual visitor's question, "Well this is a wildlife refuge; where's the wildlife?" The wildlife is distinctly obvious, both visibly and audibly.

Neither the land-acquisition nor the development program for the refuge is yet completed, but enough has been accomplished to prove the soundness of the plans and to indicate the ultimate great value of Tamarac. Not only does it have waterfowl, but deer, bears, beavers and a variety of smaller fur animals frequent its lake and stream shores and roam the wooded ridges and slopes that lie between the lakes.

Mud Lake National Wildlife Refuge, in extreme northwestern Minnesota, is a leading example of breeding-ground restoration. Its 66,596 acres of marshes and lakes, once the greatest breeding area in the state, was almost totally destroyed in 1911 by drainage. However, the agricultural land anticipated by the promoters was not obtained as the soil proved too poor.

It is unfortunate that this and many other areas have been drained without careful advance study of the probable advantages and disadvantages. The great sums spent upon them could have been put to more useful work, and restoration would have been unnecessary. Perhaps the public has learned this lesson although it seems doubtful, for even in recent months conservationists have been roundly denounced by money-grabbing promoters of similar fantastic schemes for no more than suggesting that investigation should be made before drainage is actually begun.

The drained Mud Lake, before restoration, was a dreary place. Only a few wet spots and a few water-filled ditches supported aquatic life. The surrounding weedy and bushy lowlands almost concealed the feeble attempts at agriculture that were still in evidence. Vast burned out pits—some still burning—attested the fate of peat marshes when fire gets started. Some of these peat

burns were six or more feet deep, and had destroyed all vegetation and, worse yet, all prospects of vegetation for years to come.

Such was the scene in 1936. The land has since been acquired, major construction work completed, and water levels restored. The area is again a land of shallow waters, marshy sloughs, and pot-hole lakes, ready to serve the needs of an increasing waterfowl population as vegetation is restored. In some parts this will take many years, but in other areas less thoroughly devastated recovery is well on the way.

Mud Lake is a nesting ground for fifteen species of ducks and also a feeding resort of primary importance for the great flights of ducks and geese that use the Red River Valley both spring and fall. Blue, snow, Hutchins's, Canada, and white-fronted geese visit it regularly and in increasing numbers.

This maze of waterways, lakes, and ponds is also a favorite home for the moose, white-tailed deer, black bear, beaver, muskrat and mink. Sharp-tailed grouse are common residents. On an early June visit, numerous broods of pintails and mallards were found sailing Mud Lake waters, and redheads, canvas-backs, black ducks, blue-winged teals, shovellers, ruddies and baldpates were common and widely distributed. A few green-winged teals were noted and a single white-fronted goose, accompanied by a small Canada (probably a Hutchins's) goose, were still stalking about the edges of a mud flat. Shorebirds of various kinds were present in numbers, giving promise for the future of the development. Only time can complete the rehabilitation, but in the interval most of the land can be growing food for wildlife and producing wildlife itself in a number of forms.

The Souris River Refuges. In north-central North Dakota, the Souris (or Mouse) River enters North Dakota from Canada and flows southeast and then north in a great horseshoe before again entering Canada on its way toward Hudson Bay. In the early part of the century the Souris marshes were among America's most notorious duck slaughtering places. Gunners flocked there from all sides and ammunition was shipped in by the carload.

Then drainage stopped the killing by eliminating the marshes and the ducks and geese had to find other feeding grounds. Attempts at agriculture were more successful here than in many other drained areas but no outstanding agricultural success was achieved. Then the drought came, one dry season following another with monotonous regularity. One by one the lakes dis-

PLATE 19

THE SAGE GROUSE, ONCE THOUGHT DOOMED TO EXTINCTION IS NOW COMING BACK

It is an increasingly common bird on the great game ranges and waterfowl refuges in the West.

Fish and Wildlife Service photograph by Ernest J. Greenwalt, Charles Sheldon Antelope Range

PLATE 20

MANY UPLAND FORMS OF WILDLIFE FREQUENT BOTH WATERFOWL REFUGES AND UPLAND AREAS

Upper left. The white-tailed deer is abundant on the Aransas National Wildlife Refuge.

Fish and Wildlife Service photograph by J. O. Stevenson

Upper right. Raccoons are abundant on southern refuges.

Fish and Wildlife Service photograph, Louisiana

Lower left. Wild turkeys, largest of American upland game birds, are found on many waterfowl refuges.

Fish and Wildlife Service photograph by H. L. Blakey, Ozark Mountains, Mo.

Lower right. Cottontails quickly take advantage of any refuge containing a bit of dry land and suitable cover established within their natural range.

Fish and Wildlife Service photograph

appeared, ground water subsided, wells went dry, and formerly productive lands stood parched and barren. The people were desperate and the federal government appropriated drought-relief funds to provide some means of livelihood for them until the rains returned. Part of this money was allotted to the Biological Survey to restore marshes. Burnie Maurek, a former state game commissioner and a man who had known the Souris marshes at their best, had fought long and hard for their restoration without success. Darling called him in, gave him the job, money to do it with, and started him for North Dakota in February with instructions to get busy and have the marshes ready for the ducks in April. Maurek started but it took years instead of months to make his dreams come true.

The three great refuge units that now lie along the Souris and its main tributary, the Des Lacs, are those dreams, glorified and expanded as the possibilities unfolded, and translated into such realities as dikes, fences, water-control gates, dams, patrol roads, thousands of acres of water and more thousands of acres of the right kinds of vegetation. Now the great Souris marshes stretch as far as the eye can see, the air above is alive with winging birds and the winds filled with their clamoring voices.

The three refuge units serve one major purpose—the restoration of an important duck nursery that had long been unproductive and the development of an equally useful feeding and resting ground for northern birds (see map). Incidentally, but not accidentally, they also provide flood-control protection for the city of Minot and several smaller towns, and furnish a continuous flow of clean water through the town of Minot instead of a flash run-off in the spring dwindling to a series of mud holes in late summer. They provide irrigation water for thousands of acres of hay land between the Upper and Lower Souris refuges, and last but not least facilities for fishing, swimming, picnicking, and other out-of-door recreations in a district where these are far from plentiful.

The Upper Souris National Wildlife Refuge (31,996 acres) starts near the Canadian line and consists of a series of marshes impounded by low dikes across the valley, and a great storage unit known as Lake Darling. This lake, some thirty-five miles in length when filled, is formed by the largest dam yet constructed in the waterfowl refuge program. It is capable of storing some 112,000 acre-feet of water and is the main reservoir for maintain-

ing marsh levels below it on the Upper Souris and all of the marshes on the Lower Souris many miles down the river.

The Des Lacs National Wildlife Refuge (13,981 acres) performs the same functions on one of the main tributaries of the Souris. Water-control structures make it possible to divert the impounded water into any one of three lakes, or into a marsh between the middle and lower lake, or to send it down to the Lower Souris.

The Lower Souris National Wildlife Refuge (58,453 acres) contains the most extensive marshes and the greatest waterfowl population. Here a number of dikes across the valley makes it possible to regulate the water level in the marshes. Loss by evaporation is compensated by releasing water from Lake Darling far upstream, so that levels can be maintained as seems most desirable. The system is so designed that if all marshes and storage units are filled to capacity the refuge can pass through two seasons of complete failure of run-off and still serve its purposes.

Despite the continuance of drought, it was possible to build up the supply by confining the available water to a smaller area and thus reduce evaporation and seepage. While 1941 provided comparatively little spring run-off an above-normal summer rainfall brought these units to the best conditions since their establishment.

Each year since flooding, these marshes have been improving until now they begin to look like those that vanished. The upper two river refuges have been surprisingly productive of waterfowl, as well as of such upland game birds as sharp-tailed grouse, ring-necked pheasants, Hungarian partridges and prairie chickens. Some 241 species and subspecies of birds have been recorded from the Lower Souris Refuge alone. It is impossible to list all of these here but they include thriving colonies of such interesting and little-known birds as Baird's sparrows and Sprague's pipits. Chestnut-collared longspurs are abundant and every water bird found in the region is represented at some season of the year. This refuge has attracted some fifteen species of ducks to breed, and it is one of the few places where all five species of grebes found in the northern United States can be found nesting. Here, however, the pied-billed, horned, eared, Holboell's and western grebe are all apparently equally at home.

Beavers and muskrats have become so plentiful as to be almost a nuisance and the increase in deer population has been phe-

nomenal. Estimated at about 100 in 1935, a population of 750 animals was revealed by a census by airplane in the spring of 1941. The "deer line" caused by overbrowsing of trees was becoming visible and it was apparent that the refuge management would have to remove part of the animals. Trapping the deer seemed out of the question for a variety of reasons, so an experimentally managed hunt was undertaken in coöperation with the state game and fish department. Some 400 animals were killed, with no accidents to hunters, and few cripples left to die. Each animal was measured, weighed, sexed, and examined for parasites, and other data were collected at checking stations. This experience, when analyzed, should furnish information that can be profitably applied to the management of other herds which we know will soon exceed the carrying capacities of their ranges.

Lostwood National Wildlife Refuge (23,891 acres), although just to the west of the Des Lacs Refuge, is not a part of the Souris system. It is a gravelly moraine containing numerous ponds, pot holes and lakes that produce an astonishing crop of ducks in years of good rainfall and include enough deep water to provide for the birds in the driest years. Nothing can be done to increase the water supply in droughts but even so the refuge provides a good breeding ground in dry, and an excellent one in wet, years. A number of small ponds may produce more birds per acre than would the same area of water in one lake, and Lostwood Refuge accordingly produces more than its water surface would indicate. Pintails, mallards, redheads and canvas-backs were conspicuous among the birds seen on a visit during the breeding season, and sharp-tailed grouse were common and widely distributed. Chestnut-collared longspurs were as abundant as seemed posible for a small ground-nesting bird.

Easement Refuges. While there is one other major refuge in North Dakota which should be mentioned, it is a part of the James River system and will be discussed elsewhere. The usually smaller easement refuges were first established in North Dakota and the greater number are still there, although there are now similar projects in South Dakota, Montana, Colorado and Wyoming. The name for this series of refuges refers to the plan under which they were obtained by permanent easements from the land-owners giving the Service the right to flood the land and maintain a refuge. The drought years had taught the farmers the value of water conservation and they were glad to make arrange-

ments that would provide permanent impoundments of water on their lands. Easements were obtained in North Dakota on sixty-eight areas varying in size from 160 to 15,000 acres and impoundment structures were built with drought-relief labor. County officials and local residents generally coöperated enthusiastically. Wherever possible, structures were so planned that when the impounded waters reached spillway levels the depth would be great enough to withstand one year's evaporation and still leave some water. Thus, permanent water was provided in the vicinity of the many other ponds, which in spring have water enough to attract nesting waterfowl, but which may dry up before the young birds are on the wing. However, guided by their mothers, they are able to walk across country for several miles if necessary and these deeper units provide insurance that many will reach the indispensable water.

The easement-refuge program was very successful. It cost little, as the only land purchased was that on which permanent structures were built. The only drawback is that the easements carry no right of management. The Service can build and maintain the water-control structures, and post and patrol the area against hunting, but can do nothing to control grazing and other uses. Some of these refuges are potentially so productive that they have been included in the purchase program in order to permit management and full utilization for waterfowl. Numbers of them are as valuable, acre for acre, as any of the larger and more pretentious developments.

Altogether there are now sixty-eight of these refuges in North Dakota, eight in Montana, five in South Dakota, and one each in Colorado and Wyoming, with a total acreage of 138,538. This figure fluctuates as new lands are added or unusable areas eliminated. The total number is also subject to change. In some cases two easement refuges may be combined for administrative purposes, and one or two have been found of too little value to be retained.

A glance at the accompanying map will show the distribution in North Dakota. Their value is obvious to anyone who knows conditions in that state. Many feasible projects of this type remain throughout the northern Great Plains, and the ultimate objective should be the storage of as much run-off as possible in small marshes. This work is of value for both flood and erosion control, and other federal agencies are making impoundments

similar to those on the easement refuges. State game departments, conscious of the benefits to both waterfowl and upland game birds, are developing similar projects with state aid funds. From the migratory waterfowl standpoint every such pond is a definite gain, whether it be a refuge or not.

The James River refuges accomplish the same things as does the Souris group, although on a smaller scale. From the north, they include *Arrowwood National Wildlife Refuge* (16,041 acres) above the town of Jamestown; *Dakota Lake National Wildlife Refuge* (2633 acres), an easement area just north of the South Dakota line, both in North Dakota; and *Sand Lake National Wildlife Refuge* (19,904 acres) near Aberdeen, South Dakota.

Each of these three refuges has a series of low dikes built across the somewhat narrow valley of the James River to catch and store the run-off in small units numerous enough to insure the presence of permanent water.

The Arrowwood impoundments have never been filled sufficiently to allow any overflow to lands downstream until 1942. During that season the main reservoirs as well as the smaller ponds on tributaries were filled to capacity. This refuge, of lakes and marshes with rolling hills on either side, is an ideal nesting place for waterfowl and upland game birds. Comparatively easy to patrol, its usefulness will continue to grow as the restoration of vegetation proceeds. In the management of these prairie refuges the Service has planned to restore the native grasses on the margins of the impoundments with the hope that their restoration, in addition to stopping erosion, would furnish acceptable nesting sites for the prairie chicken and sharp-tailed grouse, two species adversely affected by agricultural developments. This hope seems destined to be rewarded, for each year finds more refuges with small populations of one or both of these birds.

The Dakota Lake National Wildlife Refuge has a single dam, which stores in an old river bed the water from tributaries that enter the James below Arrowwood. It has overflowed each year since construction and the water that passes over its spillway, together with the small amounts entering the James between the two projects, has filled the upper units of the Sand Lake Refuge. In 1941, for the first time, enough water was available to fill both units of Sand Lake. These three refuges have stored all the run-off of the James basin above the farthest downstream dike on Sand Lake without releasing any water to augment floods on the

lower river except in 1942 and it is probable that with rare exceptions their impoundment structures will render the same service in future years.

Sand Lake National Wildlife Refuge is famous for its huge colony of Franklin's gulls, which has grown steadily since water was first impounded (see map). Surveys made by refuge personnel indicate that there were 6000 nests in 1937, 6100 in 1938, 20,000 in 1939, 40,000 in 1940, and between 40,000 and 45,000 in 1941. This bird city is appreciated not only by the visiting ornithologists and other naturalists but by the neighboring farmers who recognize the services of the gulls in destroying grasshoppers and other injurious insects. Circling flocks of these beautiful little gulls follow the plow, eagerly dropping into the newly turned furrow to glean exposed insects and grubs. The hungry birds often alight on the still moving soil and, for their greed, get a tumble. In summer the flocks roam pastures and fields in search of insects to feed their hungry young.

Sand Lake is noteworthy also in another aspect. The land that lies between the waters' edge and the boundary fences is among the most productive of ring-necked pheasant coverts. The number of broods that can be flushed there on a June day is unbelievable unless one has experienced it, and the great crop of birds they combine to form is equally hard to comprehend. In 1940 the state of South Dakota trapped birds here for release in depleted or understocked districts at a cost for trapping and removal of forty-four cents per bird—a most profitable transaction to the state. Eight thousand, four hundred were taken but so many remained that those removed could hardly be missed.

Nearby *Waubay National Wildlife Refuge,* a small purchase unit of 2587 acres, is administered from Sand Lake. It consists of a series of small lakes and ponds in a glacial moraine and is one of our best units according to production per acre. It is a charming spot which the whistling swan, white-fronted and Canada geese and many species of migrating ducks find and use.

Lacreek National Wildlife Refuge, lying in southern South Dakota west of the Missouri River, is small (9682 acres) as restoration projects go and, unlike many others, is not dependent upon run-off for its water supply. That comes from a clear spring-fed stream and, with the favorable location, gives the refuge an importance greater than its size would indicate. It attracts migrating birds and also harbors ten breeding species of ducks. Avocets,

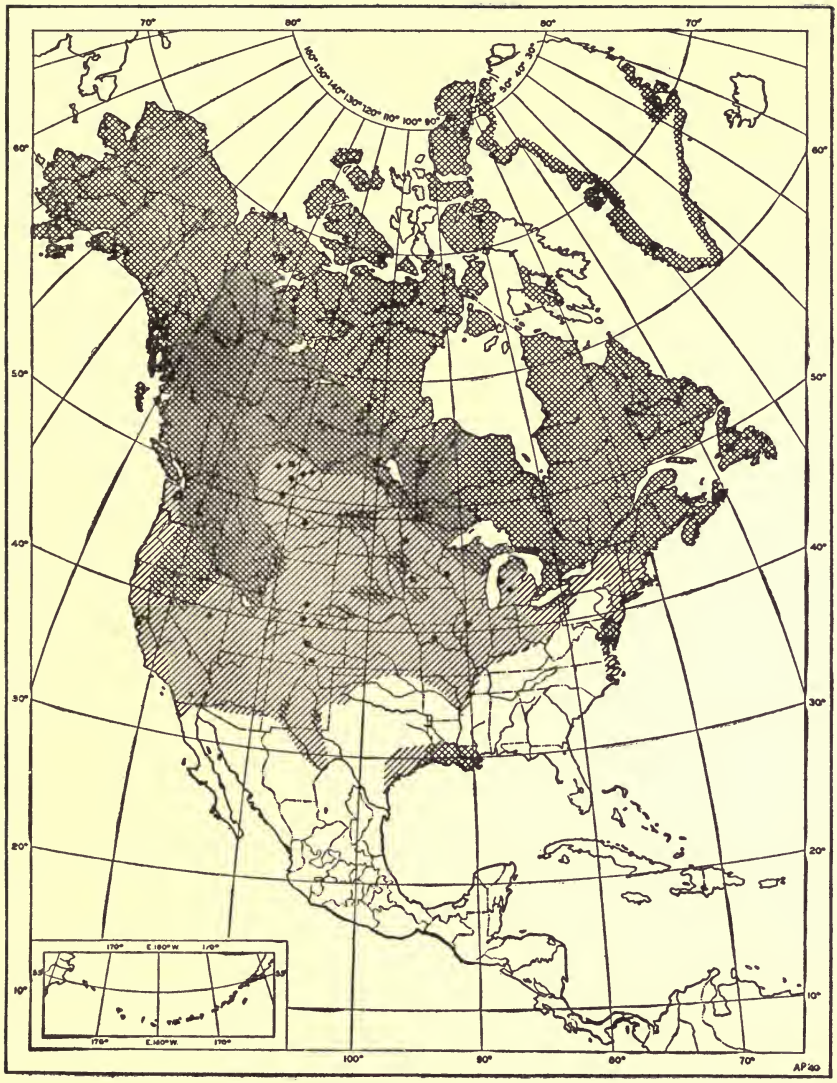

FIG. 5. Migratory waterfowl breeding area in North America is represented by the shaded areas. The lighter shading indicates the area in which much of the breeding marshes have been destroyed. Heavier shading indicates the area in which original breeding grounds are still largely available.

Fig. 6. Wintering in grounds of North American waterfowl. Shaded areas show regions of greatest concentration; the solid black line indicates normal northern wintering limit for scattered flocks; encircled areas to the north are local wintering grounds used in varying degree according to the season. This map vividly depicts the limited wintering grounds that are available to the birds.

Fig. 7. Returns from ducks banded at Lower Souris Refuge. This is both a great breeding ground and a stopping place for migrants from the North. Note the wide dispersion of the birds but also the preponderance of Mississippi Valley records. Ducks produced here and those that feed here on migration provide sport in many States and Canadian Provinces.

Fig. 8. Returns from ducks and geese banded at Bear River Refuge, another great breeding ground and stop-over for migrants. Note preponderance of California and Utah returns. Returns from Alaska and the northern Canadian territories would be greater if a greater human population were present to collect the bands. The same is probably true in Mexico.

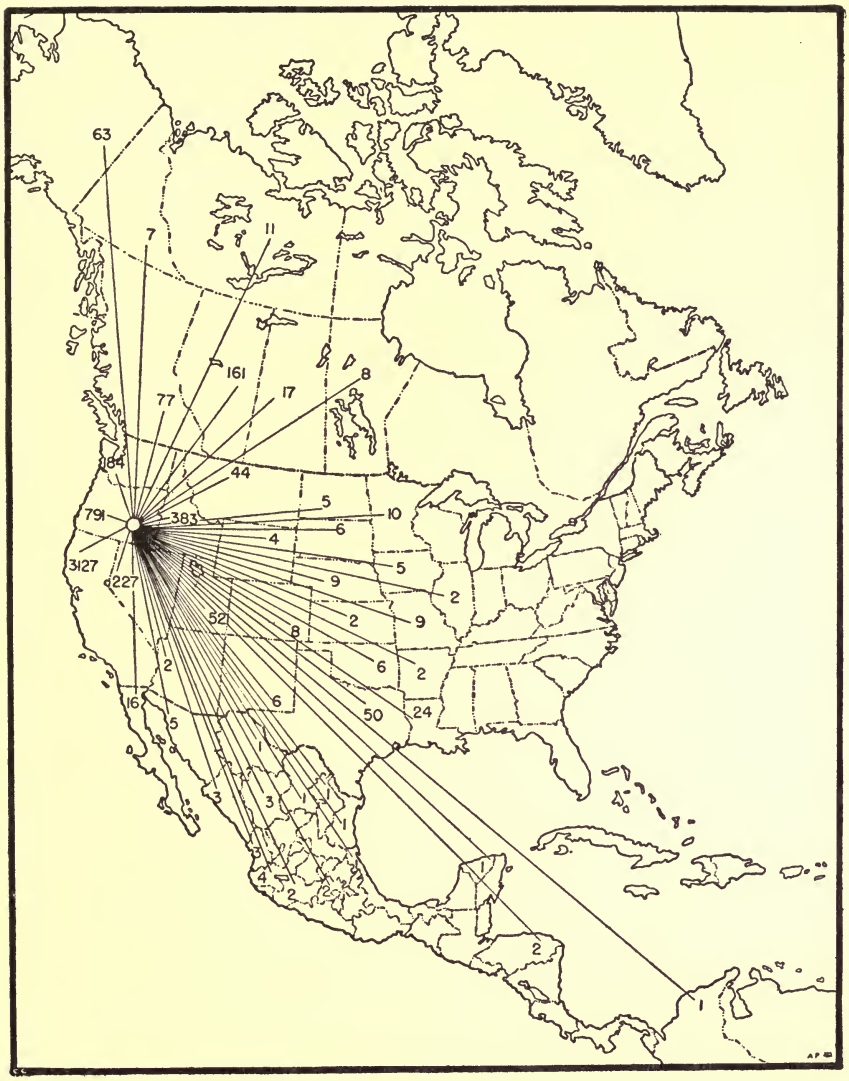

Fig. 9. Returns from ducks banded at Malheur Refuge. This is not only a breeding ground but also a feeding ground for northern birds. The wide dispersion of birds from this and other breeding grounds represents to a considerable extent the wanderings of the young of the year.

FIG. 10. Returns from Franklin gulls banded at Sand Lake Refuge.

FIG. 11. Returns from ducks and geese banded at Mattamuskeet Refuge, a major wintering ground especially valuable for geese and swans.

willets, Wilson's phalaropes and sharp-tailed grouse are also common breeders, and a fine population of lark buntings, chestnut-collared longspurs, bobolinks, and other small grassland birds occurs.

The Sandhill Refuges in northern Nebraska represent the southernmost part of the famous Great Plains breeding grounds. Once a richly productive waterfowl locality, the sandhills have suffered from a combination of drought and overgrazing until the present breeding stock is far below that of former times. Two refuges have been established there—*Crescent Lake National Wildlife Refuge* (42,635 acres), one of the first acquisitions started with Migratory Bird Conservation Act money, and *Valentine National Wildlife Refuge* (66,448 acres). They are essentially the same in general character, consisting of lakes, ponds and marshes among low sandhills. Each has been fenced so that the vegetation can be restored by control of grazing. In neither area has it been possible to augment greatly the water supply and consequently, as in the remainder of the sandhills, lake levels have been low in recent years. In 1942 better precipitation raised the water levels here as well as in most other Great Plains refuges.

The blue-winged teal, shoveller, mallard, ruddy duck, pintail, redhead, canvas-back, baldpate, scaup and green-winged teal nest, some of these at their most southern point in the Midwest.

Crescent Lake has the largest breeding population of long-billed curlews of any refuge. Conspicuous black and white avocets, noisy willets, graceful black terns, and shy upland plovers are also common nesters, especially at Valentine.

Medicine Lake National Wildlife Refuge (31,458 acres) is in extreme northeastern Montana in territory much like that on the Souris River. This restoration centers about Medicine Lake, which was so large and shallow that normal run-off from its watershed was insufficient to prevent its annually becoming nearly, if not entirely, dry. Engineering surveys showed possibilities of diverting additional water into it, hence it was purchased and by a somewhat intricate system of controls part of the flood waters of Muddy Creek can be added to those which normally enter through Lake Creek. As a result, Medicine Lake has been full for several seasons to a depth greater than ever before. These water controls have been utilized to fill numerous pot holes as well. One of the greatest colonies of eared grebes in the entire refuge system is found here, and there are colonies of black terns, black-crowned

night herons and white pelicans. Canvas-backs and redheads seem to be taking an especial liking to Medicine Lake, and numerous other species of ducks breed in abundance.

Red Rock Lakes National Wildlife Refuge, Montana (32,174 acres), is scenically the most beautiful of all. It lies in a high saucer-like mountain valley, entirely surrounded by a jagged skyline of rugged mountains. The lakes are clustered in the deepest part of the saucer and are surrounded by marshes. This refuge is nationally known for its remnant colony of trumpeter swans which, together with those in Yellowstone Park, are the sole survivors of these great birds in the United States. The area was obtained largely to conserve this species and the effort to date has been fairly successful. Starting in 1935, the annual censuses gave the following numbers of birds: 1935, 75; 1936, 114; 1937, 168; 1938, 148; 1939, 202; 1940, 190; and 1941, 211. This would indicate a reasonable response to protection. As an additional precaution, young birds have been moved to Malheur Lake, Oregon, and Jackson Hole, Wyoming, where the presence of open water throughout the year makes it possible for the swans to remain permanently on these sanctuaries. It is hoped that when these birds reach breeding age, they will mate, and increase, and gradually establish other nesting colonies.

Present-day trumpeter swans do not migrate, being apparently non-migratory remnants of a species that, as a rule, was migratory in its days of greater abundance. The Red Rock Lakes birds wander to some extent but the majority of them winter on the open water created by a big spring on the refuge. The Yellowstone Park swan also are largely resident. The limited wintering areas available will restrict the number of birds that can be produced and so it might be for the best if some of them should revert to the ancestral migratory habit.

Red Rock Lakes Refuge is so associated with the trumpeters that few realize it has other values. However, at least seventeen species of ducks nest in its marshes, among them the canvasback and redhead—two that were in need of special protection.

Camas National Wildlife Refuge (10,535 acres), located not far from the north fork of the Snake River in east central Idaho, is a most unusual waterfowl breeding ground. The water supply is limited and the contour of the land is such that big impoundments are not feasible. Skillful handling of the water to obtain the greatest possible benefit is therefore required. By taking ad-

PLATE 21

THE ANHINGA, OR WATER-TURKEY, FINDS SUITABLE HOME ON MANY SOUTHERN REFUGES

Anhinga and young.

National Audubon Society photograph by Allan D. Cruickshank, Florida

PLATE 22

THE REFUGES EXTEND FROM THE DESERTS OF THE SOUTHWEST TO THE ARCTIC WATERS

Upper. Sea-lion pup on Bogoslof Island National Wildlife Refuge.

Fish and Wildlife Service photograph by O. J. Murie

Lower. The Virgin Mountains, now washed by the waters of Lake Meade, offer suitable homes for mountain sheep and desert birds. Boulder Canyon National Wildlife Refuge.

Fish and Wildlife Service photograph by Stanley G. Jewett

vantage of natural depressions, a network of small ponds and sloughs has been created. The intervening ridges and flats, with perennial cover, provide abundant nesting accommodations for the ducks. Ten or more species breed here and large numbers stop in migration. Both antelopes and sage hens frequent the sage-grown uplands, and such birds as great blue and black-crowned night herons, bitterns, white pelicans, long-billed curlews, avocets, willets and killdeers also nest regularly. This refuge required a minimum of development before becoming useful to the birds, and consequently became a productive breeding unit in a relatively short time.

Bear River Migratory Bird Refuge, Utah (58,816 acres), acquired and constructed under a special act of Congress (1928), was the first waterfowl refuge to be specifically created by law. The original legislation also authorized appropriation of funds for the development of marshes. Formerly Bear River water, reduced by diversions for irrigation, spread thinly over the vast expanse of mud flats exposed by the recession of Great Salt Lake and created conditions favorable to outbreaks of botulism. Thousands of wildfowl perished there, and the desire to eliminate this vast death trap furnished the impetus for the reservation. Engineering work there has developed our first great man-made waterfowl marsh. It is fortunate indeed that the Service had an opportunity to gain this experience in construction and development before the big restoration program started in 1934 and 1935.

The Bear River Refuge now provides one of the great bird spectacles of the continent and because of its ready accessibility to established travel routes is perhaps the best place for the average person to see a "million" birds. Actually twice that great a concentration has been calculated to be on the refuge at one time (see map). To the unaccustomed observer the water, the shore line, and the air seem to be filled with birds when the actual numbers are far less than a million. Any time during the summer and fall the dikes and waters appear covered with resting birds. Great white banks of solemn pelicans sit along the shore and avocets, willets, black-necked stilts, snowy egrets and white-faced glossy ibises are numerous.

This is a famous redhead nesting ground and also one of the best breeding areas for Canada geese, probably ranking next to Malheur in the number of goslings produced. Numerous other waterfowl and non-game birds also nest.

The refuge headquarters, built close to the diversion works that divide the waters of Bear River and pass them into the various units, always has a bird exhibit of its own. The waters pouring over the spillway are the favorite hunting grounds for herons, Forster's terns, snowy egrets, cormorants, and even an occasional kingfisher. In fact, the show here is so good that many visitors watch the ever-changing panorama of bird life at this vantage point, and depart entirely satisfied with what they have seen. A few take time to go to the dikes where they can see the infinitely greater spectacle of life presented by the marshes themselves.

Bear River is the headquarters for some of the research into management problems which the Service has constantly under way. The traveling laboratory for the study of methods of controlling botulism has its home station here. A building for use in this work is provided on the grounds and portable equipment mounted on a truck enables technicians to visit the scene of any outbreaks, do any necessary work there, and return to Bear River with their specimens for any further study required.

An intensive study of the behavior of Canada geese carried on simultaneously here and at Malheur has already yielded information that can be applied to advantage in developing other goose-breeding marshes. Similar studies on ducks now under way should yield equally valuable results.

Ruby Lake National Wildlife Refuge (35,578 acres), at the east base of the Ruby Mountains in north-central Nevada, is a restoration of a somewhat different kind. Although fed by springs as well as run-off, the great flat lake beds were so extensive that the supply of water often was exhausted by evaporation. The lakes of April frequently become dry alkali flats by August, to the great detriment of wildlife.

The development plan calls for a collecting ditch and two dikes across the old lake bed. The available water will first be used to fill and maintain the level of the central unit. If a later supply suffices, one, or both, of the other units may be flooded. The central unit, retaining accumulated water from year to year, will tend to build up a greater water surface.

From a scenic standpoint this refuge, lying in the shadow of the ruggedly beautiful Ruby range, is one of the more outstanding. It is a great wildlife resort and is one of the few refuges with breeding sandhill cranes. Canada geese and a great variety

of ducks, among which pintails, green-winged teals, gadwalls and mallards are most common, find suitable summer homes in the marshes.

The regional complement of small birds and mammals also is represented in varying numbers. This small life is one of the features that makes the refuge so attractive. Not so usual, but no less attractive, are the mountain quail, "blue" grouse, and ruffed grouse that venture out of the mountain canyons, even near the home of the refuge manager during the winter, to form as novel an assortment of dooryard fowls as one could wish. The great mule deer bucks and smaller and sleeker does likewise take advantage of this sanctuary.

Cave Creek, which pours out of a cave as an icy stream, is the principal source of water. It furnishes power for the refuge electrical system and the water supply for a fish hatchery operated in coöperation with Elko County. This was formerly one of Nevada's best wildlife areas and the improvement already made indicates a permanent return to that status when development is completed.

Turnbull National Wildlife Refuge (10,909 acres), located near the town of Cheney and some twenty miles south of Spokane, Washington, illustrates what can be done by the reflooding of an old drainage district. It originally consisted of a number of lakes, ponds and marshes overlying a porous lava bed that extends for miles. Construction of a few low dams in the old drainage ditches and a few very inexpensive dikes for the purpose of obtaining a better distribution of water, will restore what was once one of the finest nesting grounds in the Northwest. Local naturalists tell almost unbelievable stories of the multitudes of birds breeding in former years.

Before the restoration started, the scattered ponds that remained harbored surprising numbers of breeding ducks. At the time the first reconnaissance was made, mallards, pintails, shovellers, and green-winged, blue-winged and cinnamon teals, canvasbacks and redheads were all present and breeding. Ruffed and Columbian sharp-tailed grouse among native species were observed at the same time, and introduced ring-necked pheasants and Hungarian partridges were widely distributed. Since development has been undertaken chuckar partridges, released by the Washington state game commission, have nested and may eventually establish themselves.

Malheur National Wildlife Refuge, Oregon (174,161 acres), is the last but by no means the least of the breeding-ground restorations that will be mentioned. Once one of the biological wonders of the continent, it was gradually destroyed through diversion of water for irrigation. Withdrawn as a refuge in 1908, it remained a waterfowl paradise until about 1926. From that time it shrank rapidly and in the early 1930's, one could, in late summer, drive a car over the exposed lake bottom. The colony-nesting birds were dispersed and the migratory waterfowl ceased to stop and nest. Only remnants existed of what had been one of the great wildlife spectacles of the country. My first visit in 1919 is still a vivid memory. Standing on Cole Island, a low grassy ridge projecting into the lake, there was before me a milling mass of birds that covered the water as far as I could see with a pair of eight-power binoculars.

A small group in Oregon, who never gave up hope, fought first to save and then to restore Malheur. The process of restoration was simple physically but difficult of arrangement from legal and financial standpoints. Malheur Lake together with Harney Lake is the sump for a vast watershed including the south slope of the Blue Mountains and the west slope of the Steens. The Silvies River, rising on the former, failed to reach the lake in most years after irrigation developed in Harney Valley. When the Blitzen, rising in the Steens, was increasingly diverted the fate of the lake was settled. Acquisition of the "P" ranch, which owned most of the water rights to the latter stream, offered the only hope of restoration. For years the price was prohibitive but changes in economic conditions decreased the valuation and the new waterfowl conservation program made money available. This ranch, itself a fine breeding ground, was purchased and the water again commenced to flow into the lake. The restoration dreamed of for years had started but much hard work remained to make it a reality.

First, the eastern third of the lake was cut off by an eleven-mile dike. This held the waters in the deeper part of the lake bed but provision was made to allow reflooding of the entire bed if enough water became available. Water controls on the "P" ranch were rebuilt and simplified to distribute the water more efficiently. The general plan provides for the maintenance of ponds, sloughs and channels in the Blitzen Valley sufficient to make the entire area available as nesting sites, and use of the

remainder of the water in the main lake where a luxuriant growth of sago pond weed provides fall food for both local birds and swarming migrants (see map).

The recent addition of the "Double O" ranch, with non-freezing ponds maintained by a great spring, completes an ideal refuge which is undoubtedly the greatest single waterfowl nursery in continental United States.

The restoration of the lake has been phenomenally successful. Every species of waterfowl previously known to nest has returned. Some 1500 to 1800 pairs of Canada geese nest each year and have put as many as 9000 young on the wing in a single season. Most of these birds build conventional goose nests in the marshes but a few erratic individuals nest on the fluted rimrocks along with the great horned owls and western red-tailed hawks. The greatest colony of breeding sandhill cranes known in the United States stalk the Malheur marshes and eleven species of ducks regularly nest.

Indicative of the richness of the fauna, more than 210 species of birds and 49 mammals have been found on the refuge. Among the four-foots are the antelope, mule deer, beaver and porcupine.

In summer Swainson's and western red-tailed hawks are abundant, while in winter great numbers of rough-legged hawks congregate to feed on the abundant small mammals. The dashing prairie falcon, the great horned owl and the golden eagle inhabit the towering basalt rims that wall the Blitzen Valley. Of all the wildlife, only the coyote and raven, both exceedingly abundant, have been shown to affect adversely the waterfowl for whose protection the refuge was created. Some control of both of these species is practiced in order to keep them within bounds.

This ends the account of typical breeding-ground restorations so far undertaken. It is by no means a complete list of the breeding grounds in the federal refuge system as a glance at the map will clearly show. It is safe to assume that every reserved marsh in Oregon, Washington, Idaho, northern Nevada, northern Utah, Wyoming, Montana, North Dakota, South Dakota, northern Nebraska, Minnesota, Wisconsin and Michigan furnishes some nesting grounds for the migratory waterfowl. Their value depends upon their extent and upon local topography and water conditions, but all contribute to waterfowl restoration. The same conclusion, of course, applies to the many impoundments made by other governmental agencies and private groups.

While those not especially managed for the benefit of the waterfowl are not so productive, they nevertheless contribute in some degree to the continental program.

FLYWAY REFUGES

These refuges are neither major breeding marshes nor normal wintering grounds, but may contain some of the elements of each. They have as their primary purpose the production of food and the assurance of safety for weary migrants on their spring and fall flights. While used for a shorter time each season than the other types, they are essential.

In watching for the evidences of their value, it becomes obvious that the birds tend to linger longer on them than they do on ponds and river bottoms in the adjoining territory. The reason is food. These refuges are so managed as to provide quantities of food for great numbers of waterfowl. With that attraction the birds naturally stay in the vicinity, flying out from time to time, but always returning to the more abundant food and the haven of safety.

Such restorations, detaining the birds on migration, tend to improve shooting opportunities for hunters living in the intermediate zone. These refuges also keep the birds out of the wintering marshes for additional days or even weeks and so lessen consumption of food supplies that should be available there during the most severe weather. Many biologists believe that winter feed establishes a limit to the upward trend of the waterfowl and that the supply should therefore be conserved in every possible way. The flyway refuges are an aid in this respect.

Often these areas are restored parts of unsuccessful drainage districts and they have been difficult to acquire because of endless legal tangles. Because they are used for a shorter period of the year, great area is not necessarily so important as it is in breeding or wintering refuges, which must feed huge numbers of birds for longer periods.

Eleven representative flyway refuges are here described:

Parker River National Wildlife Refuge in Massachusetts, not yet formally established, is mentioned because of its unusual character. While it will be a breeding marsh for black ducks, wood ducks and blue-winged teals, its chief value is expected to be in furnishing food for migrants. The acquisition difficul-

ties are great, largely because ownership is broken up into many small units. The plan contemplates enlarging an existing fresh-water marsh by raising the water level and eventually changing some brackish water marshes into fresh. The total acquisition will eventually be several thousand acres. Black ducks will undoubtedly be the first and chief users of the refuge but the area is expected gradually to attract some of the flight of Canada geese that now passes over this coastal district by offering additional protection and food. Local conservationists are keenly interested and have assisted materially in many ways in working ou the difficult problem involved.

Missisquoi National Wildlife Refuge, Vermont (now 1656 acres), on the eastern shore of Lake Champlain close to the Canadian line, is another of the flyway refuges not yet completely acquired. Like Parker River, it will be used by breeding black ducks and perhaps other species, but its primary value will be to produce additional food for the increasing number of migrating birds using the Lake Champlain route.

Montezuma National Wildlife Refuge (5789 acres) lies at the north end of Cayuga Lake, New York. Long famous as a waterfowl marsh, it was largely destroyed when a barge canal drained much of the land. Restoration of itself was simple, requiring only a low dike running along the canal and back to higher ground to hold the water of several small streams that flowed into the old marsh. However, long drawn-out difficulties to land acquisition delayed the impoundment of water for several years, but now the major engineering work has been completed and once again Montezuma will be a first-class marsh. Black ducks, mallards, blue-winged teals and doubtless other ducks will breed, but its major value will be to furnish food for the waterfowl that travel through the Finger Lakes district. This is a famous stopping place for canvas-backs, as well as for redheads, mallards, baldpates, blue-winged and green-winged teals, in both southward and northward flights.

Chautauqua National Wildlife Refuge (4474 acres) on the Illinois River bottoms near Havana, is one of the most important flyway refuges yet developed. Acquisition here was also a major trouble. Long before court procedures were finished, dikes to stabilize water levels were built and development was under way. The area is a favorite breeding ground for wood ducks and shelters a large summer population of these beautiful birds.

The management plan contemplates growing the greatest possible amount of food so that it will be available to the birds coming from the north. And how they do pile in. As many as 800,000 mallards have been reported at the height of the migration. This refuge has its greatest value during the fall and spring migrations.

A secondary, but much appreciated, use is for hook and line fishing. Surprising numbers of pan fish are caught during the summer months when fishing is allowed. In 1939, 10,138 fishermen took 67,239 fishes; in 1940, 9034 anglers caught 126,421 fishes; while in 1941 with bad water conditions 5755 fishermen took 42,465 fishes. This use results in no injury to the refuge or interference with its purpose and furnishes recreation and food for thousands of local people.

The Upper Mississippi River Wildlife and Fish Refuge, by far the largest of the flyway refuges, will be discussed in the next chapter.

Union Slough National Wildlife Refuge, Iowa, contains at present 1163 acres but when acquisition is completed will comprise more than 2000 acres. It is small but, because of its favorable location and productiveness, is of outstanding importance. Before drainage, this long narrow slough was one of the largest, if not the largest, marsh in Iowa. Restoration was achieved by installing a series of low dikes to hold water at desired levels. This simple engineering job, together with the protection afforded by fencing, will restore this marsh to its former value. With only a small portion flooded, some 60,000 ducks used it for several weeks during the fall of 1941.

The complete and enthusiastic coöperation of the state conservation commission, of the local authorities, and to a very great extent of the local residents has been an outstanding feature in the history of this small unit. There has been an astonishing lack of the schemers who so frequently try to get something for nothing in public developments of this kind.

Squaw Creek National Wildlife Refuge (6836 acres) lies in the Missouri River bottoms in extreme northwestern Missouri. As with Union Slough, its greatest value will be in furnishing a resting place and food to the southbound migrants. Formerly part of a natural marsh on the Missouri bottoms, it was drained many years ago. While the area was farmed for several years, drainage difficulties eventually brought about partial failure of agricul-

tural operations and it is now being converted to its original wildlife use.

Because of the character of the soil, construction of dikes is difficult, and the great quantities of silt brought down from the loess hills of the Missouri add materially to the troubles of maintenance and management. At present the water is admitted to a settling basin before being distributed to the main ponds. Plans to sluice the silt through the refuge are now being considered as a permanent solution of the silting problem. In fall, great numbers of waterfowl use the refuge, while in spring the migratory swarms of pintails and the great flocks of blue and snow geese that travel north along the Missouri make Squaw Creek their headquarters for days.

Swan Lake National Wildlife Refuge (10,672 acres) in central Missouri has been restored from another drainage district that proved unsuccessful. A few bits of very productive land were scattered over the old lake bottom that was drained but in the average year the area was a jungle of cockleburs, Spanish needles and other weeds. Here again, complicated and long drawn-out land-purchase activity was necessitated by legal technicalities. The land is now practically all owned by the Service and development has been carried on by a CCC camp. Restoration involved several problems. The most important were diking out the muddy silt-laden water of one stream and impounding the clear water of another. Muddy water does not make good lakes and marshes, because it interferes with the penetration of sunlight without which the aquatic plants cannot grow, no matter how rich the soil.

The first unit at Swan Lake was completed and water was impounded in 1941 but at the present rate of construction it will be some time before the second and larger unit will be ready for operation. Once the water impounding structures are finished it is planned to produce the greatest possible quantities of food for migrating waterfowl. Swan Lake lies in the center of a region in which practically every other marsh has been destroyed by stream straightening or drainage operations and it will be an important stopping place for birds that now have no feeding grounds from Kansas City to the mouth of the Missouri. The miniature jungles of weeds that existed at the time acquisition was started, harbored a surprising number of small migrating birds, mainly white-throated, white-crowned, Harris's, song, fox, Lincoln's, and savannah sparrows and goldfinches, and the restored marsh and

its bordering lands will no doubt continue to be a haven for songbirds as well as boon to weary waterfowl migrants. This area is far enough south so that with increased food production it will feed many thousands of birds through the fall months that would otherwise be forced to hurry on to the southern wintering marshes.

Big Lake National Wildlife Refuge, Arkansas (5542 acres), created in 1915, is the oldest flyway refuge. Originally a fine waterfowl habitat, lack of construction and maintenance money allowed it to deteriorate until it was so badly grown up to willows that large sections were all but useless. Clearing, reflooding, and stabilizing water level have already accomplished much to relieve this trouble and the lake is steadily becoming more valuable. The extensive willow-grown bottoms now contain many openings and pintails, mallards, green-winged teals, shovellers, ring-necked ducks, gadwalls and a few blue geese were present during an early March visit. At the same time dark banners of blackbirds streamed across the afternoon sky, headed for roosts in the willows. Red-shouldered and red-tailed hawks were common, reminding one of Okefenokee.

Big Lake is used extensively by blue-winged teals in their southern migration in September and later by all ducks that travel the Mississippi flyway. Many of the birds remain there in winter but the refuge is of greatest utility in September, October and November, and March and April. It is located at the apex of a great flyway funnel that pours birds from a wide expanse of tundra and prairie into the Mississippi bottoms. Its only fault is insufficient size to provide food for so vast a gathering of fowl. To supplement our efforts at Big Lake the acquisition and flooding of a part of the old Mingo Swamp, a few miles to the north, has been planned. When its 20,000 acres of food are also available, many more birds can be accommodated in this district both in fall and spring.

Salt Plains National Wildlife Refuge (19,459 acres), in north-central Oklahoma, was established by Executive Order in 1930 as one of the first operations under the Migratory Bird Conservation Act. Plans called for development by diverting water onto the area, but estimated costs proved in excess of available funds and no work was undertaken. Later, when money became available, the flood-control plans of the United States Army Engineers developed to the point where it seemed possible that the land would

be flooded by one of their impoundment structures. During 1941 this was completed and the fall flight of birds stopped on the new lake. The first geese arrived during the last week in September and from then the number grew constantly until on October 16 the flight reached its peak of more than 37,000 birds. White fronted and Hutchins's geese were by far the most numerous, although some 6000 snow geese, 4000 blue geese and 200 Canada geese were noted. Ducks also availed themselves of the newly flooded lands, pintails being first and blue-winged teals second in abundance. Along with them clouds of Franklin's gulls, numbering at least a half million, frequented the lake for days.

With this striking early use by the birds it is not difficult to foresee that when good food and vegetative conditions are developed the Salt Plains Refuge will be important. Its location, almost midway between the sandhills of Nebraska and the wintering marshes of the Gulf coast, in a vast territory in which there are no other marshes, greatly increases its value to the birds.

Muleshoe National Wildlife Refuge (5809 acres), in the Texas panhandle south and west of Amarillo, might be classed either as a wintering ground or flyway refuge without being far wrong. It is freely used by migrating birds but it often holds a great number of ducks through the winter. At such times spectacular concentrations of birds occur. Mallards and pintails predominate but baldpates, shovellers, green-winged teals and several species of diving ducks are also common.

The refuge consists of three lakes: Bull, Goose and Paul's lakes, with the surrounding and intervening lands. This area had been so badly overgrazed that much revegetation is necessary. Control structures and ditches have been installed so that it will be possible to concentrate the available water in one lake when necessary.

Developing additional flyway refuges will be a slow and tedious job. Acquisition of old drainage districts always encounters legal complications and restoration is often impeded by engineering difficulties. Nevertheless spring and fall feeding grounds along the main migration routes are necessary; in addition, such refuges take some of the pressure off the limited wintering marshes. Biologists informed on waterfowl conservation believe that increase of the continental waterfowl population will be limited by our ability to feed birds during the six months they spend in this country. Every flyway refuge increases that capacity.

WINTER REFUGES

In the early days of the restoration program little was said about wintering grounds. Breeding areas attracted all attention although biologists were keenly aware of the necessity of winter, as well as summer, food supplies. The wintering ground development was started at the same time but failed to get public attention because of the more spectacular restorations in the drought areas.

To be adequate, the wintering areas must above all grow great quantities of plants that provide wholesome winter food. In most localities, plants with edible seeds and tubers must furnish the food, although in the more southern waters vegetative parts of some plants remain green and edible through the winter. Because the area of wintering grounds is so limited in comparison to that of the breeding quarters, refuges there should be as large as possible and should be managed for maximum food production.

The narrow fringe of coastal marsh and the brackish-water bays and lagoons that extend from Long Island along the Atlantic and Gulf coasts to Tampico, Mexico, furnish winter homes for an overwhelming majority of the birds that use the Atlantic and Mississippi flyways. These have already been damaged by pollution both by city wastes and by salt water spread by the intracoastal canal, and if they are ever destroyed the ducks of these two flyways will vanish with them no matter how much they are protected by shooting regulations or how much good breeding grounds may still be available.

The Wildlife Service has been acquiring winter areas since 1932, intensifying the process in recent years. Plans call for a refuge in every great concentration district where management can increase the food supply over that now produced. Restoration techniques have been improved but studies are still directed at the practical problems of eliminating less valuable marsh vegetation, and of propagating, spreading and maintaining plants that produce an abundance of the seeds and tubers of value to the waterfowl.

For the purposes of this discussion the wintering refuges for waterfowl can be divided into three groups—only major units of which will be described. These three divisions are: the south Atlantic and Gulf coast groups, and the inland refuges of the southern intermountain and Pacific coast regions.

THE ATLANTIC COAST WINTERING REFUGES

There are at present along the Atlantic coast ten major units under administration, one in process of acquisition, and three or possibly four others planned for future acquirement. The majority of these are salt marshes.

Brigantine National Wildlife Refuge will ultimately contain about 9000 acres of land, not all of which has yet been acquired. Located near Atlantic City, New Jersey, it is a wintering ground for brant and is frequented also by many scaups and black ducks and by lesser numbers of other ducks. Development by aid of a CCC camp includes provision of living quarters and patrol facilities for the personnel and construction of cut-off dikes to impound fresh water along the inner edge of the marsh. While tidal salt marshes provide some food, the same acreage in fresh or slightly brackish water with a stable water level will produce much more food of higher quality. In conformity with the policy of so managing these refuges as to increase the food supply, advantage is taken of all opportunities to bring fresh water into them.

While Brigantine Refuge is for wintering birds, many that go farther south to spend the winter stop here during migration. It is also a breeding area for some species and probably will produce black ducks in considerable numbers and possibly some blue-winged teals and shovellers as does the more southerly Bombay Hook Refuge. While not designed as a shore-bird sanctuary, it is frequented by many thousands of migrating sandpipers, increasing its interest to visiting naturalists and its general conservation value.

Bombay Hook National Wildlife Refuge (13,459 acres) is a combination of fresh- and salt-water marsh lying on the south shore of Delaware Bay, Delaware. It produces numbers of black ducks and blue-winged teals and, surprisingly enough, a small number of shovellers. It is used in migration by greater snow geese in both spring and fall, the birds staying for days within its boundaries.

Canada geese as well make use of the facilities, and representatives of every species of duck that travels the Atlantic coast drop in for free "bed and board." Rails also are plentiful. These marshes rank high in muskrat production and returns from this fur crop alone will in time pay for the land.

Among the items of interest in Bombay Hook reports for

1939 was the production of one brood each of coots and gadwalls; particualrly strange is this nesting record for the gadwall, which normally makes its home in the prairie sloughs of the northern Mississippi Valley and the three large prairie provinces of Canada.

Susquehanna National Wildlife Refuge, set aside as a refuge for migratory birds by agreement with the state of Maryland and the War Department, comprises 21,210 acres in the Susquehanna Flats and the adjoining Aberdeen Proving Grounds. This is part of the most famous canvas-back resort on the continent. The Susquehanna Flats, with their luxuriant growth of wild celery, sago pondweed and redhead grass, produce the greatest food value of submerged aquatics per acre of any known to Service biologists. No wonder, therefore, that they are visited by such great numbers of canvas-backs, widgeons, redheads, and scaups in late October and early November. They make one of the great waterfowl shows of the continent—one that must be seen to be believed. During the worst of the duck shortage, when all the other historic concentration points for canvas-backs on the Atlantic coast were deserted, great numbers were still to be found here. Because of the abundance of favored food plants on the Flats, birds remain there until the food is well cleaned up or until a freeze-up drives them on.

No development of the Susquehanna Flats has been needed but each fall markers are placed along the boundary of this refuge designed to provide sanctuary in the wide and heavily hunted waters of the upper Chesapeake. It is a rare experience to see the Flats just prior to the hunting season. The birds lying in great massed rafts over the celery beds rise on thundering wings at the approach of a motor boat, only to circle once or twice and drop back to feed.

Headquarters are on a tiny island, formerly a fisheries station, where comfortable quarters are provided in an old house with a tower that commands a view in all directions.

Blackwater National Wildlife Refuge (8241 acres) embraces fresh marshes on the eastern side of Chesapeake Bay just south of Cambridge, Maryland. It produces a good crop of black ducks and blue-winged teals and is used as a migratory stopping place by many thousands of the same species and of mallards and pintails as well. It has less value as a wintering ground although some ducks remain to breed.

This refuge is a fine muskrat marsh and it is being used by the Service as a research station to determine proper management and harvesting methods for this prolific water-loving rodent. The information collected will eventually result in improvement of methods of skinning, and of stretching, drying and grading the skins; it will reveal the best time in which to trap, and how best to limit the take so that the crop but not more than the crop will be harvested. Such information will directly benefit managers of other refuges as well as owners and trappers of private marshlands.

The marshes in this vicinity are held to be as valuable per acre as adjoining farmlands and any knowledge leading to their better management will benefit the local economy.

Back Bay National Wildlife Refuge (4589 acres) * just below Norfolk on the Virginia coast is a part of a long-famous ducking ground. The refuge has been built around the holdings of two noted clubs—Princess Anne and Ragged Island—where many celebrated men, among them President Grover Cleveland, hunted in earlier days.

Back Bay is a great concentration point for Canada geese and whistling swans, many thousands of these great birds being present at the height of the season. The flock, comprising a large share of the total population of greater snow geese, stops on this refuge and sometimes spends the winter although usually it goes somewhat farther south.

Black ducks nest in small numbers and, together with pintails, baldpates, mallards and green-winged teals, are common during the fall and winter months. Usually by late November, canvasbacks and redheads move in to spend much of the winter. Back Bay is also traversed in season by a variety of other water birds as well as by swarms of shore birds.

The length of time the birds frequent the area depends upon the quantity of food, and that is controlled by water conditions. The water is normally fresh or very slightly brackish and when in that condition produces food in quantities that rival those of the upper Chesapeake. Wild celery and redhead grass, two of the most important plants, are intolerant of salt and any sudden acces-

* Acreage of land only. Several of these coastal refuges have closed areas of public waters surrounding or adjoining them, which often greatly increase the protection afforded the birds. In addition to Back Bay, Pea Island, Swanquarter, Cape Romain, St. Marks and Aransas have considerable acreage of closed waters adjacent to them.

sion of sea water quickly kills them. Back Bay is separated from the ocean by a low sand beach over which the salt water washes during violent storms.

Preservation of vegetation thus depends upon keeping out the ocean, quite a sizable task but one that was assigned to the CCC camp on the refuge. The flat beach is comparatively wide, giving an opportunity for remedial work. Dune building, using the prevailing winds as motive power, has long been tried in this region. Fences of brush or lumber built along the beach at right angles to the prevailing winds form a basis for dunes, but in this instance brush in the quantities needed was not available and money to buy sufficient lumber was likewise lacking. However, the ingenuity of the CCC men to whom the job was given proved equal to the occasion. Vast quantities of cane and bulrushes were available and the workers soon devised a quickly and easily built panel of this material. By placing successive parallels of these panels on the beach and later on the dunes created, a wide and massive barrier was created that now averages eighteen feet higher, for the thirteen-mile length of Back Bay, than the level of the beach on which the work started. The marsh vegetation from which the panels were made was cut and hauled to the only deep-water landing available, where the panels were made and then distributed. The great barge loads, pushed by tiny motor boats, often completely hidden from view, looked like foot-loose hay-stacks wandering through the marsh as they followed the somewhat tortuous channels that traverse it.

Pollution of Back Bay and Currituck Sound from Norfolk Harbor was checked in 1932 by placing a lock in the inland waterway to prevent a steady flow of water from Norfolk Harbor into Currituck Sound from whence it was blown by prevailing winds northward into Back Bay. As long as the lock gates are kept closed (except when vessels are passing through) and as long as the barrier dunes hold out the ocean, we can expect continuation of the improved growth of submerged plants that has occurred in recent years. Old-timers say that in the past two seasons more waterfowl have frequented Back Bay than at any previous time in the past twenty-five years. As the continental waterfowl population has not been restored to what it was that long ago, the abundance noted means that the restoration of favored food supplies has caused the birds to stay here instead of going to other feeding areas.

PLATE 23

MANY STORIES HAVE BEEN WRITTEN ABOUT THE VAST OKEFENOKEE SWAMP—NOW LARGELY A WILDLIFE REFUGE

Upper. With protection alligators are coming back in Okefenokee.
Fish and Wildlife Service photograph by Hayden Carter

Lower. The weird reflections and characteristic plants that make Okefenokee.
Fish and Wildlife Service photograph

PLATE 24

THE FLORIDA CRANE IS STILL COMMON ON KISSIMMEE PRAIRIE AND IN OTHER PARTS OF FLORIDA

The Istakpoga National Wildlife Refuge now protects a large winter roost of these great birds.

National Audubon Society photograph by Allan D. Cruickshank

Pea Island Wildlife Refuge, North Carolina (5880 acres), unlike Back Bay which includes barrier beach, islands in the bay and mainland marshes, lies entirely on the beach. It includes the land from Oregon Inlet south almost to the town of Rodanthe and the adjoining inside shallow waters and mud flats of Pamlico Sound.

First and foremost in interest, it is the usual winter home of the greater snow geese. These birds, which nest in Greenland and on North Baffin and Ellsmere islands, as far north as any of the waterfowl that winter in our country, finally come to rest on this strip of land. At times about 13,000 of the estimated total of 16,000 to 20,000 birds of this subspecies are concentrated here. The principal food is roots of marsh cordgrass (*Spartina alterniflora*), which were so completely utilized one winter that the main beds of the plants were seriously depleted. Whether the birds realized the thoroughness of the job or not, the fact is that most of them spent the following winter at Back Bay and other places away from Pea Island.

This refuge is a favorite winter resort for Canada geese and brant. To name the duck visitors would be to list all species wintering on the Carolina coast, but redheads, pintails, baldpates, black ducks, scaups and mallards are usually most abundant. Pea Island is a favorite resort for migratory shore birds, and the willet and Wilson's plover nest. At times flocks of black skimmers may be seen sweeping low over the water, and among the hordes of gulls that follow the fishermen's nets are the great black-backed gulls. This northern species is here at the southern part of its winter range but as many as a dozen have been seen within a few minutes.

Pea Island presents the same problems of maintaining a barrier beach as does Back Bay and the same method of developing wind-built dunes has been followed, except that brush is used for the paneling. Development of fresh-water marshes appeared the most practical way of increasing the value of this area for waterfowl. Dikes were thrown up inside the dunes, thus completely enclosing the salt marshes that lay on the inner side of the beach. With abundant rain these have gradually freshened until now plants that require almost absolutely fresh water grow in abundance. These ponds are often black with waterfowl which come to use the new food supply and to wash and preen their feathers.

Mattamuskeet National Waterfowl Refuge, North Carolina (50,228 acres), lies on the mainland a little south and across Pamlico Sound from Pea Island. In some respects it is unique.

First, it is the winter home for the greatest number of Canada geese and whistling swans visiting any refuge. Both species vary in number from season to season but the geese have been present in numbers estimated at from 50,000 to 75,000 and the swans from 8000 to 15,000. When so many huge birds are present they appear to be everywhere and their numbers seem far greater than any sober estimate can substantiate. The duck population is more variable, depending apparently on weather and food supplies not only here but in adjacent areas. Pintails, baldpates and black ducks are the most abundant, although most of the eastern ranging species are represented. Occasionally a white-fronted goose or a few blue geese occur, and snow geese often spend the winter.

This lake is unique in another respect, namely that the only action necessary to restore it was stopping the great pumps which had been used in an effort to create a miniature Holland. Millions of dollars were spent in this futile enterprise. Canals were dug, checker-boarding the lake, several drainage ditches were carried to Pamlico Sound to release the water, and giant pumps were installed to pump it from areas below the level of the Sound. At one time thousands of acres of the lake bed were in cultivation. Some of the land was good but much of it proved to be sandy and infertile. The crops produced never warranted the expense, and the hopeful town of New Holland never grew in accordance with the expectations of the promotors.

When the lake bed was purchased in 1934, the pumps were stopped and the big brick pump-house converted into an administration building. Boat houses, work shops and offices are on the first floor, while the rest of the building has been remodeled into a modest hotel to accommodate visitors. The smokestack now carries a lookout on its top, which is reached by a spiral iron stairway inside the chimney. In coöperation with the North Carolina Department of Conservation and Development, a small part of the lake is opearted as a public hunting ground with licensed guides and controlled blinds. The excellent fishing for crappies and large-mouthed bass is supervised under the same agreement. During the hunting season the little hotel is crowded with guests who hunt on the shooting grounds or in the vicinity of the lake. An increasing number of visitors come to the hotel in January,

February and March merely to see the great waterfowl concentration. The birds are easily observed by those who will traverse the old canal banks. For those not inclined to walk, a chair in the hotel lobby looking out over the lake is a grandstand seat from which thousands of swans, geese, and ducks can be viewed on the water and in the air.

This is one refuge on which there is too much water rather than too little. Several canals lead to Pamlico Sound and water is spilled through them at every opportunity in late winter and early spring in order to hold down the level of the lake. The chief food plants start growth best when exposed to the sunlight until they have made a fairly vigorous start, and the lower the water the greater the acreage of flats on which a quick start of these plants will occur. In late summer and early fall, on the other hand, it is desirable to have a gradually rising water level in order to make the food accessible to the birds. With normal seasonal rainfall this is easily accomplished, as drainage into the lake has been increased by ditching of lands back from the shore. Despite these conditions, an occasional dry fall finds the refuge with plenty of food which, because of low water, remains unavailable for the birds. Canals are being enlarged and gates installed to permit quicker control of the water level.

The greatest improvement still needed at Mattamuskeet is the development of emergent vegetation. A few small clumps of bulrush now exist and plantings of both seeds and rootstocks are being made to spread desirable vegetations. Wave action keeps the water so turbid that little or no food production now takes place in the open water. When this area becomes vegetated, the production of food will be many times increased and will not be so dependent as now on slow manipulation of the water levels.

Following completion of work on the canals, the largest remaining development task will be the planting of suitable submerged food plants and restoration to the use of the birds of more of the thousands of acres which grew up to willow and other brush in the years when the pumps were running. Some of this has been already cleared and flooded. About 400 acres of the highest land are planted to crops that furnish additional feed for the myriads of birds frequenting this refuge.

Swanquarter National Wildlife Refuge, North Carolina (15,501 acres), lying only a few miles from Mattamuskeet, is composed of salt marshes and the adjoining bays. It was purchased

in 1932 as one of the first Migratory Bird Conservation Act refuges. Both Canada geese and swans use this refuge, many of them apparently moving between Swanquarter and Mattamuskeet. In addition, black ducks, mallards, green-winged teals, pintails, scaups, old-squaws and buffle-heads frequent its sheltered waters. The buffle-heads, one of the most attractive of all our waterfowl, are often present in thousands. Old-squaws, surprisingly enough at this rather southern part of their range, are also very common.

Cape Romain National Wildlife Refuge, South Carolina (34,854 acres), just south of the mouth of the Santee River, lies in a crescent along the shores of Bulls Bay. It consists of a vast expanse of salt marsh, cut by innumerable channels into scores of islands, which are submerged at extreme tides. There are also several higher islands, the most important of which are Cape Island, Raccoon Island and Bulls Island. The first two are treeless, or nearly so, but Bull's Island is covered with a beautiful forest of live oak, magnolia, pine and palmetto. Cape Romain is one of the most important shore-bird resorts on the Atlantic coast, attracting not only migrants but also numerous nesting willets and oyster-catchers. These latter heavy-bodied, black and white birds with bright red bills sometimes may be seen at every turn of the endless channels or gathered in little companies where low tide exposes the oyster bars. Clapper rails are exceedingly abundant and there is a fine mixed assemblage of herons on one of the smaller wooded islands. One of the largest royal tern colonies on the Atlantic coast nests here each year. Laughing gulls, black skimmers and least terns also are common, and a thriving colony of brown pelicans build their rude nests just above the reach of the tides.

The beaches of the outer islands are a favorite breeding ground of the loggerhead turtle, hundreds of which crawl out on the sandy beach to deposit their eggs. Diamond-back terrapins are also found in these extensive marshes. Raccoons are exceedingly abundant and through their fondness for eggs are a nuisance to both the turtles and to the nesting birds. Bull's Island has an altogether too large population of deer for the good of the animals themselves and more especially for that of the wild turkeys which share the island. Wood ducks breed abundantly on this island and late in summer flocks of from 200 to 1500 gather on its woodland waters in company with egrets and the solemn-

looking wood ibises. Bald eagles nest on Bull's Island, as do fish crows, pileated woodpeckers and numerous smaller birds.

Dikes have been constructed on Cape and Bull's Islands, which by collecting rain water have changed about 1500 acres from salt barrens or marshes into fresh or brackish marshes. This provision of fresh-water loafing and feeding grounds has greatly increased use by waterfowl. Flocks of baldpates, pintails, mallards, black ducks, scaups and red-breasted mergansers can be flushed from the channels and bays or be found resting on the fresh-water ponds, while redheads, canvas-backs, blue-winged teals, ruddies, and buffle-heads are found regularly although less abundantly.

Bull's Island lies well offshore and contains a fine wild turkey range, which at the time of acquisition contained a stock imbued with some domestic blood. It seemed an ideal place to preserve the purest wild stock obtainable and plans were made to that end. After several years' work all of the semi-wild turkeys were removed and birds trapped in the Santee swamps substituted. These have now nested and it seems that the planting will be successful in building and maintaining a stock of pure wild birds for eventual use in restocking other suitable areas.

Savannah National Wildlife Refuge (12,685 acres), unlike most of the Atlantic wintering grounds, lies inland. Spanning the Georgia–South Carolina boundary, it lies on the Savannah River just above the town of the same name. Formerly a rice-growing section, in which water levels were controlled by dikes and water gates, the old plantation houses had disappeared and the dikes allowed to fall into disrepair following collapse of the rice industry. Since acquisition for a refuge, the old dikes have been repaired or new ones built; local men who still knew how to construct water gates were employed to build and install new ones; and an intensive experimental program for the elimination or control of the saw-grass was instituted. Much of the land had grown up to a dense jungle of saw-grass, useless alike to man or beast. This plant is positively objectionable also because it grows so vigorously as to crowd out better food and cover plants. As saw-grass has invaded many marshes, practical methods developed here will have wide application.

Wood ducks, which later concentrate in flocks of thousands on the more secluded ponds, are the greatest summer attraction. Blue-winged teals also favor this refuge, concentrations of as many as 10,000 having been noted. Pintails, mallards, black ducks,

baldpates and scaups are the most common ducks in winter, and mixed concentrations of as many as 125,000 have occurred at the height of the season.

Blackbeard Island National Wildlife Refuge (4854 acres), which lies off the Georgia coast between the mouths of the Savannah and Altamaha rivers, was originally acquired as a general wildlife refuge. Two-thirds of it is heavily wooded with a virgin forest of live oak, magnolia, pine and other trees. At acquisition the remainder was sand beach and salt marsh. However, four artesian wells have changed the diked-off marsh to fresh water and attracted an astonishing number of ducks, of which mallards, black ducks and wood ducks are most abundant. There is an overpopulation of deer, and continued efforts at live-trapping have failed to keep pace with the increase. The nine miles of outer beach are a favorite stopping place for migrating shore birds and are also used by hundreds of loggerhead turtles for egg laying.

Blackbeard Island, together with its larger neighbor, Sapeloe, was once used for the experimental introduction of foreign game birds but with the sole exception of the chachalaca from Mexico, a few of which still persist, all failed to establish themselves.

Gulf Coast Refuges

There are now six major wintering refuges on or near the Gulf coast. Starting from the east, the present units are distributed by states as follows: Florida, 1; Louisiana, 3; and Texas, 1. In addition one unit is being purchased, two others have been approved for acquisition, two more are being surveyed and at least three are needed in Texas to provide adequate feeding grounds for the hordes of birds that winter along this great coast line.

St. Marks National Wildlife Refuge (54,681 acres) on the shore of Apalachee Bay, Florida, is one of the principal wintering grounds for the Canada geese of the Mississippi flyway. Lake Mattamuskeet and Currituck and Pamlico sounds provide southern terminals for the Atlantic coast geese, and St. Marks serves the same purpose for the Mississippi Valley flight. Thousands of these great birds frequent the beaches and lagoons and quickly learn to know that they are safe on this ground.

Great rafts of scaups frequent the protected waters of Apalachee Bay, and mallards, black ducks and pintails are also abun-

dant. Every pond has its quota of alligators—animals of considerable interest to most visitors. Herons, pelicans, cormorants, gulls and terns swarm over the adjacent bays, which as closed areas are administered as part of the refuge. Many bald eagles and ospreys find winter quarters and each winter a band of ruddy turnstones takes possession of the lighthouse wharf. As one walks out on the wharf they run like a band of brightly marked, tiny chickens to the outer end of the dock, where, very unchicken-like, they take wing, circle over the water and alight toward the landward end. The process is repeated in reverse as the disturber makes his way back to the shore.

The chief improvements, aside from fencing to keep out hogs and cattle, a necessity in this part of the South, and the building of quarters, patrol roads and trails, have been the development of fresh-water marshes. Surveys showed that because of favoring topography and water supply it would be feasible to convert some 6000 of the thousands of acres of salt marsh to fresh marsh. That work has been completed except for one or two control structures which, when finished, will permit impoundment to be started.

Delta National Wildlife Refuge (45,861 acres), which as its name suggests lies in the delta of the Mississippi, Louisiana, is one of the main concentration places for migratory waterfowl, winter populations in excess of a million birds being the rule rather than the exception.

This refuge and Sabine among the federal reservations, as well as Louisiana refuges and the Rainey Refuge maintained by the National Audubon Society, lie in the main wintering grounds of the blue goose. The blue goose, and the small white Ross's goose, were for many years known only as migrants. Although the former wintered in the Louisiana marshes by the hundreds of thousands, when summer came it vanished into the northland. It was not until 1929 that a Canadian naturalist, J. Dewey Soper, solved the mystery and found its summer home to be Southampton Island in the throat of Hudson Bay and Baffin Island to the northward. From here the birds move to James Bay in the southern tip of Hudson Bay where they remain for some weeks and where Canada has provided refuges. On leaving James Bay the birds head straight for the Louisiana coast, seldom stopping except when they meet adverse weather. When that occurs, local newspapers from Michigan to Tennessee are apt to blossom out

with stories of the invasion of their territories by strange and unusual flights of birds.

As many as 300,000 geese have been estimated to be present on the Delta Refuge at one time, of which 85 per cent were blue geese. A Service biologist has worked out a rough-and-ready formula for estimating the numbers of ducks present. He informed me of the method as we climbed one of the observation towers to look over the birds that were feeding on the vast expanse of three-square sedge covering the mud flats. A small plot of ground was mapped off and the geese actually counted. Multiplying that number by 3⅓ would, according to the formula, closely approximate the actual number of ducks that could be counted on the same plot. Then by calculating the areas occupied by geese and ducks, reasonable estimates of the waterfowl population could be made.

On a January visit ducks were there in abundance. Mallards, pintails, baldpates and shovellers were scattered among the geese on the ground or swung away over the marsh in hurried flights. Canvas-backs, scaups and a few redheads were in the deeper channels and bayous, while tens of thousands of shore birds flashed their white bellies like mirrors as they turned and twisted in synchronized movements over the water.

It was a surprise to find deer tracks in these mud flats. Raccoons were almost everywhere, the wet hair of their lower legs turned upward like a rolled-back cuff to give them a curiously long-legged appearance. Omnipresent signs of muskrats foretold the day when some removel of surplus animals would be necessary if the marsh is to be maintained in proper condition.

Lacassine National Wildlife Refuge (31,125 acres) lies in central Louisiana about twenty miles inland from the Gulf. Mallards, pintails and blue- and green-winged teals are the most abundant ducks and several species of geese use it, although not to the extent that they frequent Delta to the east and Sabine to the west. It is one of the few refuges where the fulvous tree-duck nests and, like all of the southern units, is frequented by a variety of herons and ibises. Alligators, muskrats and raccoons are present in increasing numbers.

The greatest problem here, as at Savannah River, is control of saw-grass which has occupied great areas to the exclusion of better plants. Control of the water level is not practical, and fire is being used experimentally as a management tool in bettering

food conditions. There are many problems to be solved before efficient and economical methods of management are perfected.

Sabine National Wildlife Refuge (146,903 acres), the largest of the wintering grounds, includes a vast expanse of marsh extending from the Sabine River eastward to Calasieu Lake, Louisiana. Standing in the central part of this area where marsh meets sky in all directions, one gets the impression of endless flat space—of another world.

This is probably the greatest goose wintering ground of all the federal refuges. Blue and snow geese are most abundant but great numbers of white-fronted and Canada geese are also present. Because of the vast expanse and the difficulty of rapid transportation, no estimate of the complete waterfowl population has ever been possible. Reports mention closely packed flocks a mile long and 300 yards or more wide, and flying strands of the birds seem to reach from horizon to horizon.

The construction of the inland waterway has had a detrimental affect on some of these marshes and efforts at correction by using low dikes to impound rain water are being tried. On this refuge our most extensive experimental work with the use of fire as a management tool is being carried out. Carefully controlled burns are made and their effects accurately recorded. The results already show that burning under various weather conditions and at different seasons produce distinct results. The method promises to reduce the cost of maintaining preferred vegetations. Certain types of burning are almost immediately followed by intense utilization by geese, more than 100,000 of which have been observed on one series of burned areas, as against none on adjoining unburned areas.

The studies on muskrat management for southern marshes have been centered here, at Lacassine, and on the Louisiana state refuges. These investigations are still under way and will probably require several years to provide a full basis for detailed management plans. An inquiry about this work last year elicited a response about as follows from the biologist: "Well, if I had to make a recommendation on the basis of present knowledge, it would be: get your marsh in good vegetative condition (which means having as much three-square sedge as possible), build up a fair muskrat population, and then trap like —— to keep ahead of it and to prevent an overpopulation from developing."

Ducks by the thousands winter in these vast marshes and

many mottled ducks breed. A great variety of southern marsh birds and also alligators, muskrats, raccoons and deer are present. There is little dry land for miles, but the deer, as near seagoing as deer can be expected, do not seem to mind wet feet.

White River National Wildlife Refuge, Arkansas (103,134 acres), is one of the unique units of the system. It is on White River just above its juncture with the Mississippi and a few miles north of the Louisiana line. It consists entirely of overflow lands along the White River and, while it contains some 160 lakes of varying sizes which furnish waterfowl food, the small acorns of the pin oak forests are its most valuable food resource. As the rising waters of the river spread slowly over the bottoms, the ducks follow them to harvest the acorn crop. This refuge, which furnishes haven for every species of waterfowl that travels the Mississippi flyway, is best known for its enormous concentrations of mallards, estimated peak population of which are from 750,000 to 1,000,000 birds. There are so many of them that they obscure all other species.

This forested bottomland contains an abundant woodpecker population of assorted species—and so many individuals that a visitor at any time except in winter might rate it more highly as a woodpecker, than a duck, refuge.

A floating CCC camp carried on the development of the area, both at headquarters and in the field. It was found possible in a number of instances to build inexpensive dams to store a foot or two of extra water in the small lakes. The next lower lake can then be drawn down and wild millet or some other food grown on the exposed bottom. When mature, this crop is flooded by the impounded water so that ducks can feed upon it before the acorns are available. That may sound complicated but it works out very well practically. The first ducks to arrive certainly appreciate these managed areas and other food patches that are made for them.

Aransas National Wildlife Refuge (46,298 acres), which occupies the St. Charles Peninsula lying between Aransas and San Antonio bays just a few miles north of Corpus Christi, Texas, is the most recently acquired of the Gulf coast wintering grounds and the only one on the long Texas coast line. It is a famous duck and goose winter resort, still utilized by many thousands of these birds. The mottled duck nests commonly.

Even disregarding the waterfowl, Aransas in many respects

is one of the most interesting refuges. First, it is the winter home of the largest known flock of the apparently vanishing whooping crane, twenty-six of which wintered here in 1940–1941. Such unusual birds as the roseate spoonbill and reddish egret mingle with more common and widely distributed waders. Ten species of these long-legged water birds paraded for my benefit on one memorable visit, the largest list of herons and heron-like birds I ever saw on one day, and two of which—the roseate spoonbill and the reddish egret—were entirely new to me. Sennett's white-tailed hawk nests here, and white-tailed, swallow-tailed and Mississippi kites have been seen in migration.

Some 284 species of birds have been recorded from this refuge. Shore birds are exceptionally abundant as winter residents, probably more so than on any other of our refuges except Delta. A few of the rare Attwater's prairie chickens live in open lands here and the Rio Grande turkey is abundant. So abundant and widely distributed are white-tailed deer that 174 were counted from the car in a single day. A fine herd of peccaries is also present. Of all the beasts, however, the armor-plated armadillo takes the prize for queerness. Its coat so resembles medieval armor that one is surprised at the absence of rattles and squeaks as it trots about on funny-looking legs.

INTERMOUNTAIN AND PACIFIC COAST WINTER REFUGES

This group is in the region that presents the most difficult problems in providing wintering quarters for waterfowl. Nevertheless, every effort must be made in the United States, for many of the marshes and lakes of the Mexican plateau are disappearing. Those that encircled Mexico City at the time of Cortez have vanished, filled with silt from the surrounding mountains.

The west-coast marshes of Mexico are still available for the Pacific flyway birds but they are threatened with drainage and development of the same type that destroyed the central California marshes. Yet breeding grounds for the Pacific flight are in better condition than those of the middle flyways. The breeding grounds in Alaska and British Columbia are largely unimpaired; Malheur Lake, which feeds most of its birds into the California flight, has been restored and is rapidly resuming large-scale production; and Lower Klamath is on its way to restoration. It

seems obvious that if this flight of birds ever ends, it will be for lack of adequate wintering grounds. Cheap land is plentiful but water supplies for the creation and maintenance of marshes are hard to find. The Service is acutely aware of this condition and is bending every effort to find a solution.

Leaving refuges on Reclamation projects for consideration in the next chapter, there are treated here the four major wintering grounds so far developed in the central and Pacific flyways that can be managed primarily for the benefit of waterfowl. Two of them are in New Mexico and two in California. Two other refuges are under acquisition in the coastal section of Washington and one is being considered in western Oregon, but none of these is of major proportion.

The most pressing need is for two or more additional units in California. Refuge possibilities in Colorado now under consideration may help in the central flyway, but if it were not for the Reclamation projects, adequate aid to the waterfowl of this region might be entirely hopeless.

Bitter Lake National Wildlife Refuge (23,803 acres) in the Pecos River valley of New Mexico is one of the more interesting developments of the system. It comprises two units, one of which is maintained by a small dam collecting run-off in addition to water from a number of springs. The second includes a number of small gypsum-encrusted lakes fed by deep springs. An ingenious system collects these waters to maintain one of the larger lakes; a ditch, which picks up the flow from a number of seeps along a steep bluff, further provides the water which makes Bitter Lake Refuge.

A variety of ducks winter here—mallards, pintails and baldpates being most abundant. A growing number of sandhill cranes winter in this valley, causing some complaints from the farmers of damage to crops. It is not inconceivable that at some future time additional lands may be needed to provide food for the cranes and thus minimize the damage.

After the refuge was acquired a colony of nutria, a South American rodent, was found. These animals, escaped from a fur-farming enterprise, seem to be doing well and are being watched with interest.

Bosque del Apache National Wildlife Refuge (56,238 acres) borders the Rio Grande River south of Socorro, New Mexico. It embraces the entire Bosque del Apache Spanish Land Grant.

Much of it is open arid slopes inhabited by scaled quail and other desert-tolerant wildlife. Bottom lands are to be developed into an intensive winter food-producing area. A water right adequate for good crop production was obtained with the land and, after long delays occasioned by the negotiation of the interstate compact between Texas, Colorado, and New Mexico governing division of Rio Grande waters, the project is now under way. Some 6000 acres can be developed and a CCC camp was doing the necessary clearing, ditching and diking until closed by the war needs.

This is the only refuge that furnishes a nesting ground for the rare New Mexican duck, relative of the mottled duck of the Texas coast. Many other waterfowl winter, the principal ones at present being mallards, gadwalls and lesser scaups. Sandhill cranes also winter, although not in the numbers found in the Pecos Valley.

The development work here will require years, but when completed should provide for many thousands more birds than can now find food in the valley. It should help replace some of the winter range lost in Mexico, although much more will be needed ultimately if birds of the central flyway are to be preserved.

Salton Sea National Wildlife Refuge (32,407 acres) lies at the south end of the Salton Sea, California. The land was acquired in 1930 but engineering problems and the rising level of the sea have prevented development. The land is at present largely covered with salt water. While many water birds use the general region and the wintering duck population runs into the hundreds of thousands, the refuge in its present condition provides little food to meet winter needs. This, coupled with a considerable volume of crop damage by the hungry birds, creates a real problem. It is planned to develop the refuge with the double purpose of providing additional waterfowl food and reducing crop losses. The Salton Sea, together with the nearby Imperial and Havasu refuges in new Reclamation Service impoundments on the Colorado River, are the best-present known answers to the need for more wintering grounds on this flyway.

The Salton Sea is frequented by great numbers of grebes, gulls, herons and shore birds in addition to the game waterfowl. White pelicans and gull-billed terns also breed here far from any other known colonies of their kinds.

Sacramento National Wildlife Refuge (10,776 acres) lies in the heart of the Sacramento Valley, California. Nearly half of the

acreage ultimately desired has been purchased and the remainder is being acquired. Even at maximum, the refuge will be too small to care adequately for the vast congregation of birds that pours in here from the north. It is the only refuge available to the rare Ross's goose as a wintering home, and it rivals the Delta and Sabine refuges in the number of geese that use it at some time during the winter. A quarter of a million or more mixed geese, including Ross's, snow, white-fronted, cackling, lesser Canada and Canada are sometimes present. At the peak of the 1940 fall concentration an estimated 1,115,000 pintails alone were on the refuge. Like the mallards at White River, the pintails so overshadow other species that, though present in thousands, they are scarcely noted by the casual observer. This refuge shares with Bear River the distinction of being the most accessible to visitors of any of the great concentration areas. While the Bear River Refuge at times has the greater total number of birds, Sacramento furnishes sanctuary to an avian population of such unbelievable numbers as to dumfound the visitor. The west-side route of the Pacific Highway (99 W) passes for several miles along the western border of the refuge. In November 1940, some 65,000 geese and almost as many ducks feeding close to the highway are reported to have caused a traffic tie-up as the motorists stopped to watch the masses of birds.

Sacramento Refuge provides a winter home for two species of geese from widely separated regions. The cackling goose, a miniature Canada goose, weighing little more than a fat mallard, nests on the Bering Sea coast of Alaska from the mouth of the Yukon north. When it leaves its nesting grounds it apparently crosses the Pacific to Willapa Harbor, Washington, thence flies to Tule Lake in northern California, and finally to the Sacramento Valley where it winters. The tiny white Ross's goose crosses Canada diagonally in a southwesterly direction from the Perry River region on the Arctic coast east of the Mackenzie delta where its nesting ground was finally discovered in 1940 by Angus Gavin of the Hudson's Bay Company.

Willapa National Wildlife Refuge in Washington (2544 acres) has been only partially acquired. It is located at an important stopping place for the geese that winter in California's central valleys and for the coast-loving black brant as well. It is also a wintering ground for mallards, baldpates, pintails and a variety of deep-water ducks; its capacity, however, is decidedly limited

by present underproduction of food. When land acquisition has been completed, proper management can add greatly to the food resources, especially for the geese. The present area consists of a part of Long Island and surrounding waters and a small area on the mainland Willapa Bay in addition to being a great waterfowl concentration point, is also a very favored stop-over for migratory shore birds. On my last visit, in late October 1941, after the geese had departed for the south, pintails, green-winged teals, mallards and white-winged scoters were present as well as black-bellied and semipalmated plovers, killdeers, western sandpipers and sanderlings. Two black pigeon hawks and a Peale's falcon were also noted. This refuge is destined to grow in importance, both as a wintering ground and for flyway use, but it can never be made to support such enormous concentrations of birds as center around the Sacramento.

FUTURE NEEDS

It is obvious from the accompanying map that the major gaps in wintering refuge areas are in California and Texas. Flyway refuges are still too few in Colorado and in the western parts of the plains states. Scattered winter reservations are needed elsewhere and of course additional breeding grounds wherever and whenever possible. At present the only new major project in the breeding category is Horicon Marsh, Wisconsin. Here a 30,000-acre marsh, historic as a waterfowl resort, is being purchased jointly by the Wisconsin Conservation Department and the Fish and Wildlife Service. Approximately two-thirds of the land has been acquired. Horicon, like Malheur and other devastated areas, became conservation battleground during the long years when wildlife interests fought a seemingly hopeless battle for their restoration.

There is much yet to be accomplished before we can feel that the safety of the waterfowl is definitely assured. The spectacular part of the refuge program is past but the harder gruelling fight to hold what we have gained and continue to make progress toward the ultimate goal is still with us in grim earnest.

CHAPTER XIII

Refuges on Lands Used Primarily for Other Purposes

Numerous federal refuges are on lands owned or controlled by other agencies. Lower Klamath, the first waterfowl refuge, was established on a Reclamation withdrawal. This and the refuges later placed on Reclamation projects were founded by mutual agreement between the Reclamation Service of the Department of the Interior and the Biological Survey of the Department of Agriculture. At the time, little could be done to protect or develop such refuges because of lack of funds, nevertheless they helped in providing safe stoping places for the birds. Much of the protection was provided by Reclamation Service employees and state officials, as the Biological Survey then had no patrol force.

In 1934 Congress passed an act for the better coördination of wildlife-conservation activities, generally referred to as the Coordination Act. Among other things it provided that "whenever the Federal Government, through the Bureau of Reclamation or otherwise, impounds water for any use, opportunity shall be given to the Bureau of Fisheries and/or the Bureau of Biological Survey to make such use of the impounded waters for fish cultural stations and migratory bird resting and nesting areas as are not inconsistent with the primary use of such waters and/or the constitutional rights of the States."

Since the two bureaus mentioned have been consolidated into the Fish and Wildlife Service of the Department of the Interior, the coördinating act permits full consideration of wildlife needs on any impoundments created by federal agencies.

By far the most numerous and important refuges established on other lands are the twenty-seven on Reclamation withdrawals. Areas operated in coöperation with the Grazing Service are next in rank, there being five of these and a part of the sixth—the San Andres—on grazing-district lands. The remainder of the San Andres and three other refuges are on national forests; one is on Coast Guard property; one was created with the coöperation of the Departments of War and Treasury (Willapa); two are on

PLATE 25

OKEFENOKEE NATIONAL WILDLIFE REFUGE IS ONE OF THE GREAT WILDLIFE AREAS OF THE CONTINENT

Upper. Billy's lake and other open waters are well stocked with fish.
Fish and Wildlife Service photograph by John M. Hopkins

Lower left. The Florida crane is abundant. This youngster is about ready to leave home.
Fish and Wildlife Service photograph by Hayden Carter

Lower right. Nest of Florida crane.
Fish and Wildlife Service photograph by John M. Hopkins

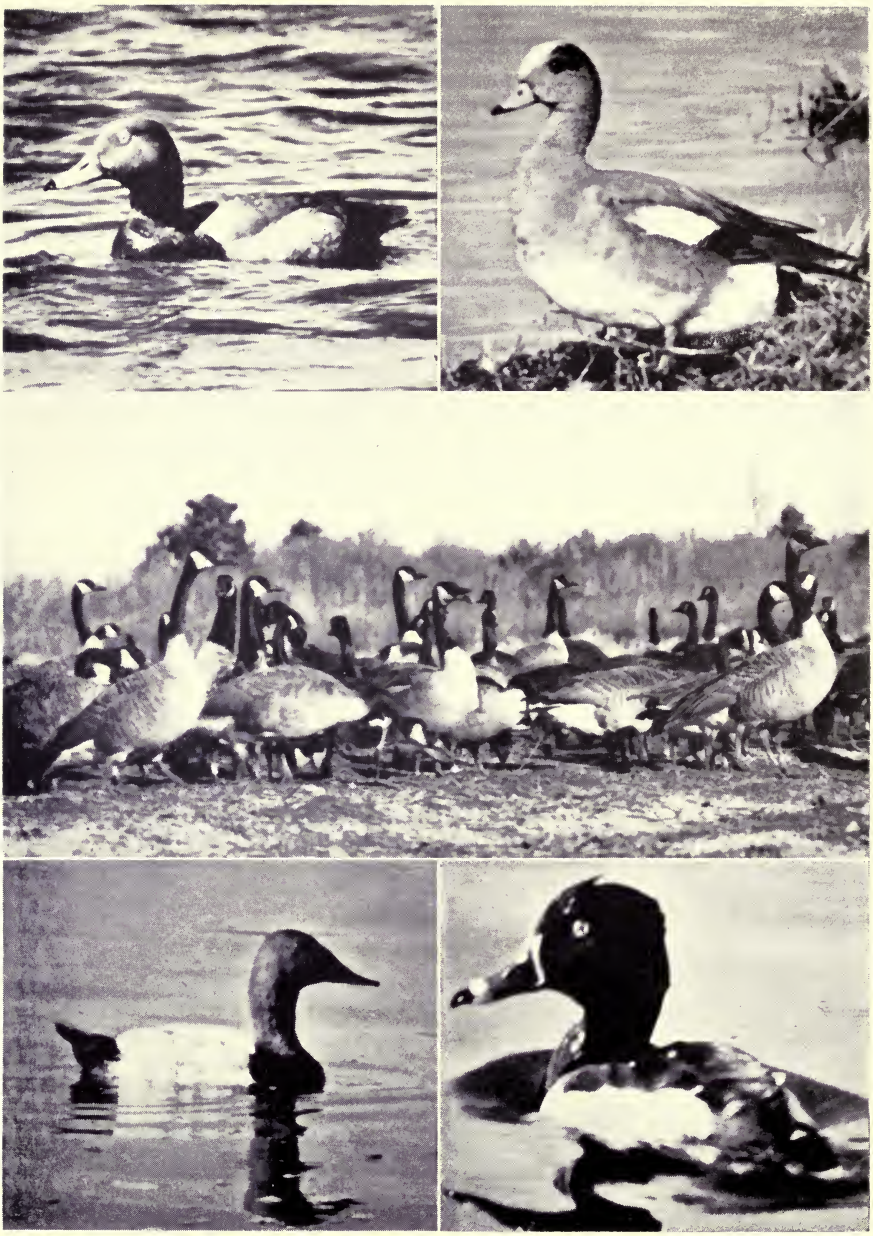

PLATE 26

THE RESTORATION OF MARSHLANDS FOR WILDLIFE WAS MADE POSSIBLE BY THE DESPERATE PLIGHT OF THE WATER-FOWL

Upper left. The redhead was one of the most endangered species. Upper Souris National Wildlife Refuge.

Upper right. The baldpate has increased greatly in numbers. Lower Souris National Wildlife Refuge.

Center. Canada geese on Mattamuskeet National Wildlife Refuge.

Lower left. The lordly canvas-back is breeding on restored marshes.

Lower right. The ring-necked ducks have spread to new breeding areas.

Fish and Wildlife Service photographs by W. F. Kubichek. Last two photos from Lower Souris Refuge.

India Service lands; two are on Bureau of Animal Industry holdings, one of which is operated coöperatively with the Montana Fish and Game Commission; and on one, the Upper Mississippi River Wildlife and Fish Refuge which was established by a special act of Congress, navigation rights are reserved to the War Department.

REFUGES ON RECLAMATION SERVICE AREAS

The Reclamation areas utilized may be either sumps or storage reservoirs. They vary widely in value, their location and manner of operation greatly affecting their utility for waterfowl. Generally, although not always, those in which the water level fluctuates violently produce little food and are used by the birds only as resting, preening and drinking places. In the arid western states where the majority of these projects are located, even this limited use may be of considerable value. Hence the policy has been followed of establishing refuges wherever the flight of birds seemed to justify without too much regard for food-producing capacity.

The Klamath Group of Refuges. The waterfowl refuges in the Klamath basin are by far the most valuable of those operated on areas used primarily for other purposes. Located at the junction of two major flights to the Pacific flyway, they at times attract birds whose numbers can only be computed in hundreds of thousands and occasionally even in millions.

Of the four units, three are in California and one in Oregon. Clear Lake, California (25,300 acres), is a storage reservoir as is Upper Klamath, Oregon (8140 acres), the refuge area including only a small part of the large Upper Klamath Lake. Tule Lake (37,340 acres) is the main sump for the irrigated lands of the basin; and Lower Klamath, formerly a large marsh in both California and Oregon, when restored will comprise about 20,000 acres, largely in California.

Lower Klamath was established as a refuge in 1908. At that time it was a vast marshy lake, equal or perhaps even superior to Malheur as a biological wonderland. It was then an overflow sump of more than 80,000 acres. While it received some water from small creeks, its principal source of water was backwater from the Klamath River when in flood. The construction of a small dam diverted this water from the lake and permitted it

to evaporate until the only remaining marsh was that maintained by the flow of the small streams.

In the meantime Tule Lake, once known as Rhett Lake, also was shrinking. Originally fed by Lost River, the use of that stream for irrigation, together with construction of a by-pass canal which permitted diversion of surplus water into the Klamath River, Tule Lake dwindled in size and importance although its use as a sump by the Reclamation Service prevented its entire disappearance. With the irrigation of more land, more water eventually found its way into the sump and Tule Lake grew back to its present size. It was made a refuge in 1928. Clear Lake, the storage reservoir at the head of Lost River, became a refuge in 1911, and Upper Klamath in 1928.

Much acrimonious criticism of the Reclamation Service has been voiced by conservationists who remembered the glories of Lower Klamath in its prime. It is true that reclamation work destroyed it and also for a time greatly impaired the value of Tule Lake. It is further to be admitted that difficulties arose between the representatives of the two Services over details of administration, and wildlife, having only secondary rights, often got the worst of it. In all fairness, however, it must be said that a review of the case demonstrates that the faults were not entirely on one side. It now appears that mutual lack of appreciation of the other Service's problems was the real root of the trouble, rather than, as was sometimes alleged by extremists, that the Biological Survey wanted to take over the entire project for the birds or that the Reclamation Service didn't care if it exterminated them.

It is certain that when the two Services started to discuss their viewpoints and problems, things began to improve for the birds, and what was even more important, common grounds on which the two managements could meet became apparent. As one result of the better coöperation, a major concentration of cackling and white-fronted geese from the coasts of Alaska and of snow geese and lesser Canadas from the Mackenzie delta in Canada finds better conditions during its stay. Klamath basin is one of the great goose resorts of the continent.

Let us consider for a moment the difficulties that arise on such a dual project. The Reclamation Service must fill the reservoirs of Upper Klamath and Clear Lake in the winter and spring and draw them down as needed during the irrigation season. Overflow

from the spillways then commences to come into the sump and Tule Lake begins to rise in June when the nesting season is at its height. This sometimes floods out nests. On the other hand, the normal draw down of Clear Lake comes at a time that greatly reduces its value for breeding purposes and also reduces the production of aquatic food plants. The Fish and Wildlife Service needs muskrats on Tule Lake to keep the marshes open; the Reclamation Service wants them kept out to protect the dikes. The Reclamation group, in order to keep up income for the project, wants to farm every possible acre of the sump; the Wildlife Service wants as much as possible of it to grow duck and goose food.

There are many other minor points of difference. Those cited show the diverse interests of the two Services. The fact that, despite such extreme divergences in objectives, a successful management program was finally initiated indicates that a genuine desire to work together is the most important factor in making a success of such refuges. As a result of mutual understanding, Tule Lake has become a key refuge—one of the most important in the national system; Clear Lake is greatly improved; and the major construction work necessary to restore wildlife productivity on between one-fourth and one-third of Lower Klamath will be completed this year.

Attaining these results has involved concessions on minor points without sacrificing essentials of either program. In illustration, it may be pointed out that one of the causes of nest destruction and the consequent decrease in value of Clear Lake was removed when the Reclamation Service permitted the Fish and Wildlike Service to fence parts of the shore line and thus preserve nesting cover for the birds that would otherwise have been destroyed by livestock.

Clear Lake is primarily a goose-nesting territory, but many ducks now breed along its shores since vegetation has been allowed to develop. The largest colony of white pelicans in the United States is on this refuge; it comprised about 2000 pairs in 1941. There is a mixed colony of California and ring-billed gulls, one of Caspian terns, and one of blue herons, which here violate their tradition of nesting in trees to build with the pelicans in the sagebrush.

Tule Lake was greatly improved when the Reclamation Service agreed to diking of some 6000 acres of land as a secondary

sump, into which excess water could be diverted to prevent too great a rise in the main lake. It is at present a fine nesting area producing quantities of ducks, particularly redheads, pintails, gadwalls, mallards and cinnamon teals. It also has fine nesting colonies of such interesting birds as the avocet and black-necked stilt; and its shore line is one of the great pheasant- and quail-producing areas of northern California. While it is an important nesting ground, its greatest value to waterfowl arises from fall and spring use by great numbers of migrating geese and ducks. At the height of the season, only the Sacramento Refuge and the Delta and Sabine refuges in Louisiana can boast a mixed goose population rivaling that of Tule Lake, and few if any protect a greater number or variety of ducks.

As a result of increased irrigation of lands above Tule Lake, a greater annual volume of water has recently been flowing into the sump. Even the 6000 acres diked off by the Fish and Wildlife Service were insufficient to store all the overflow and when the dikes broke, several thousand acres of good croplands were flooded. As this condition promised to get worse instead of better, a plan was evolved whereby the Reclamation Service undertook to build a tunnel and pump through it excess water from Tule Lake into Lower Klamath. This water will be used to irrigate some benchlands and then released into the old lake bed. The Fish and Wildlife Service undertook to build a dike along the Oregon–California boundary to impound this and other waters on approximately 20,000 acres of the former bottom of Lower Klamath Lake. The two Services presented a joint program which was approved and money was appropriated for the work which is well along toward completion. This plan does not destroy the Tule Lake Refuge, but supplements it with another 20,000 acres of marshland. Arrangements have also been made to lead water into the sump from other sources so that a satisfactory water level can be maintained at Lower Klamath. This is a fine example of the coöperation between the two Services which produces mutually helpful results without major sacrifice of either wildlife or irrigation interests.

The Lower Colorado Refuges. Of great present importance and of even greater potential value among Reclamation reservoir projects is the lower Colorado group of refuges. This includes 658,497 acres in Lake Meade impounded by Boulder Dam; the Havasu Refuge of 37,370 acres behind Parker Dam; and the Im-

perial of 47,841 acres farther down the river. These three refuges offer the greatest hope of developing adequate wintering ground for the Pacific coast flight of birds, although the two Services (Reclamation and Fish and Wildlife) are working together to provide additional marshlands to replace those lost in the San Joaquin Valley by construction of the Central Valley project. Lake Meade itself has comparatively little value for waterfowl except as a resting place. However, improvements in the valley of Muddy Creek and Virgin River, which flow into the lake, will provide food for migratory waterfowl. The ducks have already found these partially completed developments and congregate there in thousands during the winter months. Great numbers of wood ibises, snowy and American egrets, blue herons, night herons, and other non-game water birds also are at home here. The improvement consists of dikes designed partially to stabilize water levels and thus favor a greater production of food than would occur if the water fluctuated directly with that of the main lake.

However, greater possibilities seem to inhere in the two refuges farther down the river, as the fluctuations of water level will be much less in these impoundments than at Boulder. Much silt will be held back by Boulder Dam and the turbidity of the water thus reduced. These new refuges will have many acres of shallow water suitable for the production of submerged food plants, and both are being carefully studied so that the best developments may be adopted. They are already furnishing winter homes for waterfowl and, with an increased production of food, should accommodate many thousands of wintering birds. Development of refuge lands near Salton Sea will provide wintering grounds which, while not so great as those that have been lost, will help insure perpetuation of at least a part of the Pacific coast flight.

It is impracticable to discuss here all of the twenty-seven refuges that have been set up on Reclamation projects. They are in every western state from Arizona and New Mexico to Montana and South Dakota. However, a few are so outstandingly valuable that it seems best to make some mention of them.

Bowdoin Lake in Montana, containing 11,546 acres, ranks high in value. It is a first-class breeding ground, being as productive, acre for acre, as many of the best refuges. Suitable land is there, the only difficulty being the water supply. Coöperation between the two Services again solved the problem. The Fish

and Wildlife Service paid $40,000 toward the construction of an additional reservoir desired by the irrigation interests and in return received a perpetual, annual water right of 3500 acre-feet for use on this refuge. This water is to be furnished as nearly as possible when we desire it, except during the peak of irrigation demands. This seems a fair proposition and no difficulties have developed over it. Colonies of pelicans, blue herons, cormorants and gulls are present each year, and sage hens, antelopes and Canada geese are also present on the reservation. With an assured water supply and plans made for diverting other waters into the lake, Bowdoin should be a first rank permanent producing unit.

Deer Flat in Idaho, a reservoir of some 10,252 acres, is an important wintering refuge. Lying in the Snake River valley, it provides a resting place for many waterfowls. Because of unfavorable water fluctuation during the growing season, however, it produces comparatively little food. Estimates of a duck population of between half a million to a million birds here have been made in recent years. Lacking food on the refuges, the birds have done considerable damage to crops in recent years.

Minidoka Reservoir in Idaho, where 25,332 acres have been set aside as a refuge since 1909, deserves special mention because its value has been greatly increased during the past few years under a coöperative program. In some of the shallow arms and bays, cut-off dikes have been constructed and equipped with valve gates which permit water to flow into these small impoundments as the lake rises, and retain it as the water drops in the large reservoir. These partially stabilized water areas, totaling several thousand acres have yielded a satisfactory increase in aquatic plant foods. One visiting the refuge is struck immediately by the concentration of the birds on these small units. It is a vivid demonstration of the greater productive value of stabilized, in contrast to fluctuating, water levels. This same practice can be applied with equally good results on many other refuges. In some cases physical conditions are not favorable for this type of development but new processes constantly being devised may be used for their improvement.

There are twelve refuges on Reclamation reservoirs that have value as breeding grounds as well as for resting places for migrants. These are scattered through the states of Montana, Oregon, Nevada, Utah, Wyoming and South Dakota. No one is a major

producing unit, but each contributes hundreds or even thousands of waterfowl to the annual crop, and in addition furnishes food and safety for many migrants. If it were not for these reservoir resting places, many districts that now enjoy a fair migratory waterfowl flight would have very few of these birds especially during the fall months.

It should be remembered that many waterfowl are produced outside the reservoirs and sumps of these irrigation districts. These birds commonly nest along the canals and in the little marshy areas that appear throughout irrigated lands. Such scattered production on many western irrigation districts of cinnamon teals, mallard and pintails is distinctly helpful.

This coöperative attitude of the Reclamation Service is particularly helpful, as it enables us to coördinate refuge plans with progress on reclamation projects as they are developed. The preservation of existing marshes or formation of new marshes to replace those that may be destroyed can thus be considered from the very inception of the project. Joint studies and engineering surveys to carry out such a program are now under way on the Central Valley project in California.

The Fish and Wildlife Service is also studying the Grand Coulee project in eastern Washington in order to assure maximum advantages from it for wildlife without undue interference with the major purposes of the undertaking.

A list of the national wildlife refuges on Reclamation projects, and their acreages follows:

Boulder Canyon, Ariz. and Calif., 658,497 acres; Havasu, Calif. and Ariz., 37,370 acres; Imperial, Calif. and Ariz., 47,841 acres; Salt River, Ariz., 21,120 acres; Clear Lake, Calif., 25,300 acres; Lower Klamath, Calif., approx. 20,000 acres; Salton Sea, Calif., 32,407 acres; Tule Lake, Calif., 37,340 acres; Deer Flat, Idaho, 10,252 acres; Minidoka, Idaho, 25,332 acres; Bowdoin, Montana, 11,546 acres; Pishkun, Montana, 6195 acres; Willow Creek, Montana, 3199 acres; North Platte, Nebraska, 5107 acres; Fallon, Nevada, 17,902 acres; Winnemucca, Nevada, 9806 acres; Carlsbad, New Mexico, 16,234 acres; Rio Grande, New Mexico, 73,228 acres; Cold Springs, Oregon, 2677 acres; McKay Creek, Oregon, 1813 acres; Thief Valley, Oregon, 1495 acres; Upper Klamath, Oregon, 8140 acres; Belle Fourche, S. Dak., 13,680 acres; Strawberry Valley, Utah, 14,080 acres; Conconully, Wash., 933 acres; Lenore Lake, Wash., 6159 acres; Pathfinder, Wyo., 46,341 acres.

REFUGES ON GRAZING SERVICE LANDS

All the refuges on Grazing Service lands are big-game ranges that have been discussed previously. There are now five of these with a sixth, the San Andres in New Mexico, partly on a Grazing District and partly on a national forest. These refuges are established by Executive Order upon joint recommendations of the two Services as to the reservation of such ranges and forage reserves as are needed for wildlife. The Fish and Wildlife Service administers the wildlife and the Grazing Service the domestic stock. Cabeza Prieta and Kofa in Arizona, Fort Peck in Montana, and the Charles Sheldon Antelope Range and the Desert Game Range in Nevada are now in operation.

REFUGES ON NATIONAL FORESTS

There are three small refuges on national forests, two of them in southeastern Alaska. The first, *Forrester Island,* contains 3400 acres and provides suitable breeding grounds for murres, auklets, puffins and guillemots. The second, *Hazy Islands,* 100 acres, is a part of the Tongass National Forest and contains similar colonies of sea birds. The third refuge is the *Apache* in Arizona, a small but very good waterfowl breeding area on the Apache National Forest that contains 2674 acres. This refuge has been improved by the Forest Service following plans developed jointly by the two Services. A fourth, the San Andres refuge previously mentoned, lies partly on the Jornado Experimental Range.

REFUGE ON TENNESSEE VALLEY AUTHORITY LAND

The *Wheeler Refuge* of 38,448 acres, in northern Alabama, occupies part of the lake of that name impounded by a TVA dam. Although comparatively new, it has already become a stopping place for migratory waterfowl. The management and improvement projects undertaken by the two agencies are expected to provide additional food and thus make the area even more attractive. The experimental de-watering project, in which water is taken from land as a malaria-control measure, while a crop of duck food, such as wild millet, is grown to be made available to the ducks in the fall by reflooding, is being followed with great interest. This process is almost the reverse of that described for

Minidoka, and it will favor production of winter rather than summer food.

This practice, together with cultivation of small patches of land lying here and there along the lake, should ultimately increase the available food. A number of Canada geese have already accepted Wheeler Refuge as a wintering home, though it is used principally by ducks in the spring and fall migrations. The greatest concentrations have been observed during the northbound flight when large numbers of mallards, pintails and other birds avail themselves of the food and safety offered. Snow and blue geese also stop to feed on the refuge and a few winter.

The Wheeler Refuge is especially valuable through providing food and safety in a district where there are few large bodies of water. Further coöperative projects should be developed with the TVA and other refuges established to meet the needs of the waterfowl of the region. Because of the vast impoundments created by this authority, the opportunities for further migratory waterfowl development are great and full advantage should be taken of them

THE SANTEE-COOPER

As a result of an agreement with the South Carolina Public Service Commission, a unique refuge is being developed on the Santee-Cooper power-producing impoundment. The Santee-Cooper project will destroy some of the finest waterfowl lands in South Carolina and an effort is being made to compensate for that in some degree by developing feeding grounds upon the main reservoir by the plan used so successfully on the Minidoka. Cut-off dikes are being built across shallow bays and arms to stabilize the water level and provide favorable conditions for the growth of a supply of aquatic food plants. The total area so cut off will be insignificant in comparison to that of the entire reservoir, but it will provide food for thousands of wintering birds. Other plans, tentative as yet, are being discussed for safeguarding or salvaging as much as possible of the lowland marshes that may be destroyed by this project.

INDIAN LAND REFUGES

Two small but very good waterfowl breeding refuges are on Indian lands in Montana. These are the Nine Pipe reservation of

2088 acres, and the nearby Pablo Refuge of 2868 acres. Only a few miles apart and a short distance from the National Bison Range, they are administered by the superintendent of that refuge. Both are excellent breeding grounds, and for their size as productive as any refuge. A day's visit to each revealed a surprising variety and number of migratory waterfowl, including broods or mated pairs of mallards, redheads, cinnamon teals, shovellers and gadwalls. Other species are reported to breed.

Hundreds of ring-necked pheasants nest along the margins of the reservoirs that are the central features of these reservations.

When these refuges were established in 1928, bitter protests were made by local sportsmen on the ground that they would be deprived of all shooting. It was gratifying, therefore, to hear the man who led the fight against them admit publicly that he had been entirely mistaken; that the refuges were the finest thing that had ever happened in that part of Montana; that he would probably fight even harder now if an attempt were made to discontinue them; and that what they wanted was not fewer, but more, refuges. Such a statement, coming from this man of strong convictions, indicated that the refuges themselves had done a good job of selling the program to people in that region.

MINOR COÖPERATIVE AREAS

There is one small refuge on the Washington coast, the *Willapa Migratory Waterfowl Refuge,* comprising lands controlled by the War and the Treasury departments and acreage purchased by the Service. There are two refuges on Bureau of Animal Industry Experiment Station lands—one in Montana operated in coöperation with the Bureau of Animal Industry and the Montana Game Commission, and one in Vermont. The Bureau of Animal Industry is also doing experimental work at the *Chinsegut Hill Refuge* in Florida.

COÖPERATION WITH ARMY ENGINEERS

The Upper Mississippi Wildlife and Fish Refuge Act, passed in 1924, authorized the Service to buy overflow lands of the Upper Mississippi Valley, but reserved navigation rights to the War Department. Subsequent to the purchase of much of the land by the Biological Survey, the channel-improvement project for making

a nine-foot channel from St. Louis, Missouri, to the Twin Cities, Minnesota, was started. This called for construction of a series of dams to provide slack-water navigation for river traffic. It was assumed by many conservationists that this would ruin the refuge and there was a great outcry about it. If the original plans had been followed, destruction might have resulted. However, after consultation with the Service, the Army Engineers so modified construction plans that the area, far from being destroyed, has been vastly improved. It would have been imposible for any conservation organization, operating solely for the benefit of fish and wildlife, to stabilize water levels as effectively as had now been done. In the first pool completed, the shallow bays and back-waters are already becoming vegetated and the area is becoming a fine waterfowl resort. As other pools have been placed in operation, indications of the same development are seen. Only a few of the pools, however, are yet sufficiently vegetated to be attractive. The Army Engineers have usually been coöperative in operating the pools so as to reduce the water fluctuations to a minimum although, incidental to construction or occasionally for other purposes, they have drained pools in winter and destroyed much of the aquatic vegetation as well as muskrats and fishes.

The wildlife value of the Upper Mississippi Refuge is now entirely dependent on the operation of the dams. If they are so managed as to minimize water fluctuations and to limit winter drainage of the pools, this area will become a major wildlife habitat of the midcontinent.

The vast water acreage can also provide an abundance of fishing if the fishes are not destroyed by manipulation of the water levels. If the vegetation in the back-waters is preserved, the area will more and more become a resting place for migratory waterfowl. Not only that but increasing numbers of birds, including mallards and blue-winged teals, and possibly Canada geese. may be expected to nest on the islands and along the shores. It is now one of the best wood duck producing areas, many thousands of these birds being reared annually in its wooded bottoms. In recent years a small colony of American egrets has been established near the northern boundary of the refuge. So far as known this is the most northern nesting group of this species, and it is a remarkable indication of the extent to which these formerly persecuted birds have come back under protection.

As many million people live within a few miles of this refuge,

fishing and other recreational opportunities are of vital importance. A crop of muskrats and other furs also can be taken annually, providing small incomes to people who live along the river. A trapping permit system limits the number of trappers and regulates the take of this crop. Hunting of migratory waterfowl is also allowed on some areas. The present pattern of land ownership and the physical conditions make this more a series of protective reservations rather than a single refuge.

It is easy to visualize an increasingly valuable wildlife return from this area so long as the present coöperative relationship and understanding operations on the part of the Army Engineers is continued. Careless or indifferent manipulation of water levels could soon ruin the refuge.

In accordance with the terms of the coördination act, negotiations are under way for the utilization for waterfowl refuges of other impoundments by Army Engineers. As the flood-control program grows, there will be need for further coöperation. Impoundments under those operations may provide much-needed waterfowl refuges where there is little prospect of their establishment by the Wildlife Service alone. The cost of land, or of construction, is often too high to justify the undertakings strictly for wildlife conservation. Where flood-control needs justify the costs, however, there may often be a possibility of providing refuge requirements by coöperative action. The coördination act, which has received little publicity and which has had little attention from the public, is becoming increasingly valuable in handling the problems of migratory waterfowl conservation.

With the development of the general wildlife restoration program, the need for resting and feeding units has become apparent in many districts where they were not previously considered necessary. The present minimum program was planned on the basis of known needs or of known areas in need of rehabilitation. As the waterfowl increase, new needs may develop as they overflow into districts and onto lands that have not harbored the birds in numbers for many years. That condition has already developed in a few districts, and it is the hope of those engaged in the restoration program that eventually the birds will reoccupy numerous districts from which they have long been absent.

CHAPTER XIV

Refuges Administered by Other Federal Agencies

Federal lands furnishing refuge protection to wildlife by a variety of government agencies are not included in the national refuge system administered by the Fish and Wildlife Service.

The most important are the national parks and monuments, federal wildlife refuges on national forests, and those on lands controlled by the Soil Conservation Service. There are a few refuges on lands owned by other federal agencies but they are not of major importance. These include areas on which protection depends on local administrative officers. For example, a number of Army posts have carried on excellent wildlife management, embracing the giving of refuge status to all or part of their lands. Usually such programs have been adopted on the initiative of a conservation-minded officer and they may fail when that individual leaves.

NATIONAL PARKS AND MONUMENTS

On June 30, 1942, the national park system consisted of 165 areas containing a total of 21,644,702 acres of land on which, with minor exceptions, all killing is prohibited. As most of these areas are adequately marked and patrolled, they are sanctuaries in fact as well as name.

While Yellowstone National Park (Wyoming) was established by the Act of Congress in 1872, the area did not become a completely effective wildlife sanctuary until 1894, when all hunting was prohibited. The National Park Service was created in 1916 and assumed control over the sixteen parks and twenty-one national monuments then administered by the Department of the Interior. National monuments date from 1906 when Congress authorized the President to set aside lands owned or controlled by the United States, containing historic landmarks, historic or prehistoric structures, and other objects of historic or scientific interest. It was not until 1933, however, that all such monuments,

battlefields, and historic parks were placed under one administration in the National Park Service.

These parks and monuments were not usually selected primarily for their wildlife values, although the preservation and presentation of wildlife is an important part of the park program. Aside from the twenty-six national parks and eighty-two national monuments, most of the remaining fifty-three units are too small to be of more than local significance. However, even small sanctuaries are valuable object lessons in conservation. As these units have other qualities that attract numerous visitors, their educational value may exceed that which they have in actual protection of wild creatures.

The greatest of the national parks have been chosen primarily for their scenic and inspirational values. Several of the finest are confined to higher altitudes of the mountains where conditions are not favorable for the year-round support of numerous wild creatures. These mountain heights have a fascinating flora and an interesting variety of wild forms which are often more appreciated by the observant few than by the careless multitude. The stupendous spectacle of the Grand Canyon and the magnificent ice and snow fields of Mount Rainier are in themselves more than enough to justify the permanent preservation of these areas as national parks regardless of their value to wildlife. It is not intended to minimize the wildlife utility of the parks, as they preserve habitats that meet the requirements of a great variety of species. Each guarantes that there will always be a home for the wild creatures of its zone and region. In addition there can be no question that the presence of living wild animals adds much to the enjoyment of many park visitors. I read somewhere of an old lady who could "sit all day and knit in the face of the Matterhorn." The sight of tourists feeding peanuts to the saucy golden-mantled squirrels on the rim of Crater Lake, Oregon, brought the quoted phrase vividly to mind. Yet on reflection, perhaps it shows the universal human sympathy with small and helpless living things rather than indifference to a sublime scenic spectacle. Perhaps the contrast of the small life with the vivid panorama spread before unaccustomed eyes heightened enjoyment and by contrast emphasized the vivid blues and vast distances. Whatever the reason, it is a fact that the chipmunks, the golden-mantled squirrels, the nutcrackers and jays do add greatly to the attractiveness of Crater Lake Park, in the same way that

wild creatures, large and small, contribute to the value of any landscape.

It is not intended in this book to portray the scenic wonders of the great national parks. Every visitor has attempted to put into words the impressions and inspirations received, and there is little new for anyone to say on the subject. However, it does seem appropriate to discuss here some of the major contributions of the park system to wildlife conservation that are above and beyond the general values familiar to all.

From this point of view, Yellowstone is certainly the most famous of the parks and it is perhaps the best wildlife area of all. It is larger and has a more varied topography than most of the others. Added to these advantages is the fact that it lies within the natural range of some of our most spectacular animals. Its 3470 square miles include the natural range for great herds of elk, the greatest concentration of grizzly bears remaining in the United States, likewise for one of the largest groups of Rocky Mountain sheep, fine herds of mule deer, moose, and antelopes, and the largest herds of bison in the country. In addition to these larger animals, black bear, martens and beavers are still common. Together with the Red Rock Lakes National Wildlife Refuge (Montana), Yellowstone holds the fate of the trumpeter swan as a member of the avifauna of the United States. It gives protection also to a colony of white pelicans and to a few nesting pairs of sandhill cranes. Small mammal and bird life is abundant and varied, as one would expect in this favorable habitat. The greatest value of the Yellowstone from the wildlife standpoint, however, is that it offers the best opportunity we have to preserve permanently the grizzly bear, moose, bison and mountain sheep in a wild state in this country. That alone is more than enough to classify it as the outstanding wildlife unit in the national park system.

In addition to Yellowstone, two other United States parks (Glacier in Montana and Grand Teton in Wyoming) have small groups of grizzlies; these and Isle Royale (Michigan) provide sanctuaries for moose; and at least ten parks and monuments have herds of mountain sheep. The most important to the last-named animals are Glacier, Rocky Mountain (Colorado), and Grand Canyon (Arizona) parks and Death Valley (California) National Monument. Two parks, Glacier and Mt. Rainier and Glacier Bay National Monument contain and protect mountain goats.

Mount McKinley Park, Alaska, stands next to Yellowstone Park in wildlife values. The most important larger mammals are: caribou, Dall's sheep, moose, grizzly bear and wolves. Such smaller creatures as martens, otters, wolverines and foxes are also present. Two days spent in this park provided the writer with some of the most vivid memories of a lifetime spent out of doors. Caribou were widely scattered, and mountain sheep were visible on almost every slope and cliff. Best of all, two of the wolves were very accommodating and gave us the privilege of watching them at fairly close range. An amazing variety of waterfowl was nesting on the innumerable tiny lakes; the only known nesting surfbirds and wandering tattlers have been found on its tundra-clad slopes and both were present; ptarmigan were widely distributed; and among the smaller birds, the wheatears and Bohemian waxwings, both accompanied by broods of newly fledged youngsters, were of great interest. Two crowded days were short even to glimpse the amazing variety of wildlife.

Glacier National Park, in addition to being one of the two national parks containing mountain goats, also has mountain sheep, elk, mule and white-tailed deer, and next to Yellowstone the largest number of grizzlies in any park in the United States. It also has a few individuals of such rarities as wolverines, fishers and Canada lynx.

Mt. Rainier, Washington, has black bears, mountain lions, elk and Columbian black-tailed deer, in addition to a herd of mountain goats. It is famous for alpine flower gardens, snowfields, and glaciers, and also affords the visitor the easiest opportunity in the Pacific Northwest of becoming acquainted with such dwellers on the heights as the Rainier white-tailed ptarmigan, Hepburn's rosy finch and the American pipit.

The Olympic National Park, Washington, contains the largest remaining herd of the Roosevelt elk, and is also one of the few areas in which numbers of mountain lions are still to be found. It provides permanent homes for many other species of birds and mammals characteristic of the forests of the Pacific Northwest and for that reason alone is one of the more important wildlife areas in the national park system.

Wind Cave National Park in South Dakota contains herds of bison, elk, deer and antelopes kept under fence as is done on other big-game refuges of restricted size.

Yosemite National Park, California, extending from the lower

PLATE 27

MANY FORMS OF LIFE ARE AIDED

Upper left. Avocet and young. Bear River National Wildlife Refuge.
Fish and Wildlife Service photograph by W. G. McFarland

Upper right. Black-necked stilt and nest. Bear River National Wildlife Refuge.
Fish and Wildlife Service photograph by W. G. McFarland

Center left. Long-billed curlew. Red Rock Lakes National Wildlife Refuge.
Fish and Wildlife Service photograph by W. F. Kubichek

Center right. Ring-billed gull. Medicine Lake National Wildlife Refuge.
Fish and Wildlife Service photograph by W. F. Kubichek

Lower left. Killdeer at nest. Bear River National Wildlife Refuge.
Fish and Wildlife Service photograph by W. G. McFarland

Lower right. The giant loggerhead turtles nest on several refuges.
Fish and Wildlife Service photograph

PLATE 28

BIRDS QUICKLY AVAIL THEMSELVES OF FAVORABLE NEW HABITATS

Upper. White pelicans. Clear Lake National Wildlife Refuge.
Fish and Wildlife Service photograph by Ira N. Gabrielson

Lower left. Double-crested cormorant. Bowdoin National Wildlife Refuge.
Fish and Wildlife Service photograph by W. F. Kubichek

Lower right. Brood of Canada geese. Bowdoin National Wildlife Refuge.
Fish and Wildlife Service photograph by B. M. Hazeltine

slopes to the summit of the Sierra Nevada, is an important general wildlife refuge, with its greatest value in furnishing suitable environment for a great variety of life. It has a large population of black bears, a fine herd of mule deer, and small numbers of fishers and numbers of martens—both species that are at a dangerously low ebb over most of their range. Nearby Sequoia–Kings Canyon National Park contains most of the Yosemite species, including fishers and martens and in addition Sierra bighorns and wolverines.

The Fort Jefferson National Monument, Florida, to which the Dry Tortugas Bird Refuge was added in 1935, contains the only colonies of sooty and noddy terns in the United States, and also harbors small colonies of roseate and least terns. The great sea turtles (loggerheads, green and hawksbill) haul out on its sands to lay their eggs.

The Great Smoky Mountain National Park, overlying the main Allegheny Range along the North Carolina and Tennessee boundary, will become of increasing importance to wildlife. When it was placed under administration, wildlife populations were low but it is large enough to furnish adequate year-round range for all native forms, and since its establishment the populations have already shown a gratifying increase. Situated as it is in the heart of a district that has been until recently badly overhunted, its importance is great. Black bears and white-tailed deer have definitely increased and wild turkeys are responding somewhat more slowly.

There are many other parks and monuments that might be mentioned. All of these protected areas contribute to the restoration or preservation of some form of wildlife and failure to mention other notable areas is due to limitation of space rather than to lack of appreciation of their values.

Two projected national parks when completed will have outstanding wildlife values. They are planned to preserve the Big Bend area in Texas and the Everglades of Florida. The first, well on the way to completion, will afford protection to many species of plants and mammals and birds in the middle Rio Grande country not elsewhere protected. Among them will be: antelope, black bear, mule deer, peccary, golden eagle, cougar and kit fox. The Colima warbler and Texas blue-throated hummingbird, neither of which nest elsewhere in the United States, breed here. There are two varieties of free-tailed bats found, one of which

is very rare in this country. Several species of oak are unique to this region, cactus in a multitude of forms is present and numerous other arid land plants are conspicuous.

The Everglades park, when established, will give protection to rookeries of the white ibis, wood ibis, and the American egret, snowy egret, and other species of herons, as well as to a great variety of smaller birds that frequent south Florida. American crocodiles and manatees are making their last stand here on United States soil. In truth, except for the spectacular quality of its wildlife populations, this proposed park seems somewhat below usual national park standards. As to its wildlife value, however, there can be no question. If the park should not be established, there is ample justification for a great wildlife refuge in this region.

NATIONAL FORESTS

The forested lands of the country furnish most of the big-game hunting now available to the American public. The only large game animal not of the forest is the antelope, whose home is the plains of the West which are now classed as grazing land and public domain. The national forests are the most important single element in the woodlands and because of location and better administration usually contain a better big-game population than do comparable areas of privately held forest lands. It is not within the province of this book to discuss the important contribution of the national forests to the wildlife program but rather to deal only with the refuges established on national forest lands. In addition to these, there are many notable game areas on the forests. Numerous state refuges—that is, areas closed to hunting by state legislation or by state game-department authority—also are on national forest lands but since these are included in the discussion of state refuges (Chapter XV) it is only desirable to say here that in 1941 there were 405 areas containing a total of 21,128,717 acres of national forest lands designated as game refuges.

In addition to the state reservations and the federal refuges discussed in this chapter, there is on the national forests a third type of wildlife protective area designated as "Game Areas by Administrative Restrictions." These are largely big-game habitats on which management is practiced in order to build up stocks of wildlife and provide a greater annual harvest. Use of these is

more flexible than that of the refuges, as action to solve wildlife problems does not need legislative sanction. These areas represent adaptation of the refuge concept to use as a tool in managing wildlife. Because of the greater ease with which restrictions can be either relaxed or tightened as the need arises, such administrative units can well replace refuges where big-game populations are already too large or where they threaten to become so within a few years.

There are at present twenty-six national game refuges, containing 1,433,626 acres, on national forest lands. Some of these were established by special Acts of Congress and others by Presidential or Secretarial orders under the authority of various legislative acts.

Of all of these, by far the best known and most important are the Kaibab in Arizona and the Pisgah in North Carolina. Each is a big-game refuge and each, because of its very success in building up herds, became the center of controversies between state game officials and the National Forest Service. Further, the Kaibab was the first to demonstrate the fact that refuges have definite limitations. This reservation of 754,600 acres, established in 1906 for the protection of mule deer, mountain sheep, Kaibab squirrels, dusky grouse and band-tailed pigeons, was doubtless looked upon by its sponsors as the final solution of the wildlife-conservation problem of the district. It was selected early among refuges intended to prevent the widely predicted extermination of game mammals and birds. Undoubtedly the Kaibab and other refuges created in the first quarter of the century did much to stop the decline in wildlife. Without them and the crusading conservationists responsible for their being, it is entirely probable that some of our finest wildlife species might have joined the passenger pigeon in oblivion.

The Kaibab Refuge was a success, particularly in building up the herd of mule deer. In fact, their numbers soon increased beyond the carrying capacity of the range with the inevitable consequence that the deer began to overuse, and then destroy, the best browse plants. When the Forest Service officials attempted to reduce the number of deer by hunting, it precipitated a controversy with state officials in which a wide circle of conservationists was ultimately involved. Unsuccessful attempts were made to drive the deer from the overstocked area and other schemes for remedying the situation were tried. Since this was the first occa-

sion in which a refuge was too successful, the proposal to undo all the good work of previous years by *opening the refuge to hunting* was fiercely resisted. The old bugaboo of state's rights was raised, although the courts finally upheld the contention of the federal government that it had the right to kill the deer to prevent destruction of its property. Much heat but little light was evidenced during most of the controversy but out of it has come a better understanding of the limitations of big-game refuges. Conservationists learned that, while refuges are valuable aids in building up and protecting depleted stocks, a definite correlation exists between the amount of browse and grazing produced annually and the numbers of big-game animals that can be supported. Whenever the demand for food exceeds the supply, the deer, or other animals involved, literally eat themselves from house and home. The annual yield of food declines progressively until the animals suffer wholesale starvation. Following an abrupt decline in the populations, a long and often slow recovery may take place until the district is again capable of sustaining a similar herd.

This lesson sank deeply into the minds of biologists and foresters but, despite its clear implications, numerous other "Kaibabs" have since developed. This has been largely due to the unwillingness of local sportsmen and conservation groups to admit that deer or elk populations had increased to the point where starvation might ensue. At present there is a growing appreciation of the fact that managing wildlife is very comparable to livestock farming. The available feed will support a definite number of animals—no more. Recognizing this, it is apparent that both good sense and good conservation require that a maximum limit should be set to the numbers of a herd as well as a minimum below which it should not fall. As a result of this growing understanding, managers have greater freedom of action in dealing with big-game animals. On the Kaibab itself, management is an accepted practice and the great controversy has been largely forgotten.

In later years the Pisgah refuge in North Carolina became the center of another controversy arising again from the attempt of the forest officials to reduce the deer herd. Situated in a country where deer stocks generally were low, the Pisgah under adequate control and protection eventually built up a deer population that threatened to cause a repetition of the Kaibab experience. In

efforts to remove deer by hunting and by trapping for shipment to other states and other national forests, a controversy developed with state officials which eventually reached the courts. The decision again was favorable to the federal service, though many state officials felt that the court decision did not decide the real point at issue—ownership of the game. These legal matters, however, are of no concern to this writing. The fact that is of interest is the development, under widely different conditions, of the same problem in the management of big game species on refuges.

Many of the later refuges on national forests have been created as temporary management devices for building up stocks of game in areas where they were at a low point. These are especially exemplified in the South and East—in Arkansas, Florida, Georgia, Tennessee and Virginia. Here comparatively small refuges, which serve to protect nucleus herds, have been established in large forested tracts. Increase from these herds gradually drifts onto adjoining favorable habitat, part of which may be opened to controlled hunting. To the extent that they succeed, these units may be decreased in size or even ultimately abolished. The great majority of such sanctuaries have been set aside for the benefit of deer and wild turkeys, two species that have all but vanished from many parts of the South. It is true that bears, quail, grouse and fur bearers, as well as numerous non-game species also profit by these reservations, but the major interest that carries the projects is in the deer and turkeys.

Two refuges on the Cherokee and Chattahoochee forests in Tennessee and Georgia, respectively, also furnish protection to growing herds of European wild boars. These animals were brought to this country years ago by private interests and released in territory later acquired as a part of these forests. Their population has increased slowly until in recent years widely publicized boar hunts have resulted in a limited kill. As these animals are very wary, it is probable that they resort to the refuges during the hunting seasons.

In the West, mountain sheep, elk and various grouse are beneficiaries of forest refuges. However, with the single exception of the Kaibab, these refuges have perhaps not been as important to wildlife in conservation value alone as they have been in fostering the constantly increasing application of wildlife management to forested areas.

SOIL CONSERVATION SERVICE

The Soil Conservation Service, which now administers many of the land-use projects started by the Resettlement Administration, has established on them a number of wildlife refuges. State refuges among them are included in the acreage figures given in the chapter on state refuges. In addition, there are a number of areas closed by administrative order of the Chief of the Soil Conservation Service.

Most of these lands, like those added by the Resettlement Administration to the national wildlife refuge system, were submarginal with badly depleted resources. Wildlife populations were generally low and the first step in management has been complete protection. Under closing orders are fifteen refuges with a total of 234,661 acres that are protected from two to five years, and seven containing 30,994 acres that are closed permanently. All but one of those temporarily closed are in the southern states, Arkansas having six, Louisiana two, Oklahoma three, and Texas three. The exception is a 25,215-acre area in Moffat County, Colorado. The temporarily closed areas vary from 1608 to 27,686 acres in size, while the permanent refuges are somewhat smaller.

One of the permanently closed areas is a 17,865-acre unit in Kentucky, and the other six are small impoundments in Texas. Some of these lakes have considerable value for migratory waterfowl, a value that may increase as the water areas are stabilized and aquatic plants become established.

CHAPTER XV

State Refuges

State refuges play an important part in wildlife conservation and should be considered in connection with the federal refuge system. Long before the national program was conceived, state refuges were in existence. Lake Merritt, California, the first of them (1870), antedated by many years any other refuge that still exists. It is true that Yellowstone Park was established shortly thereafter but it did not become a wildlife refuge until 1894 when an Act of Congress prohibited hunting within its boundaries.

According to available records, Indiana, which established its first refuge in 1903, was the second state to do so; the date coincided with that of the creation of the first federal refuge under the Biological Survey.

The wildlife-conservation crusade that developed in the early part of the century quickened the refuge movement as it did other phases of wildlife protection. Many species of wildlife then seemed doomed to early and inevitable extinction. Some did vanish, but the list of lost species is small compared to those considered so near the brink of extirpation that any attempt to save them seemed hopeless.

Some of them, such as the whooping crane, trumpeter swan, California condor, and ivory-billed woodpecker, are still in danger. Perhaps they will finally succumb, but not from lack of legal protection and earnest effort to save them. Of these the trumpeter swan is slowly increasing; the whooping crane seems to be about holding its own; while the other two are in greater jeopardy. Less than fifty condors and thirty ivory-billed woodpeckers are known to be alive today. The condors are protected by California law and also by a reserve in the Santa Barbara National Forest where the birds are given special protection. Despite persistent efforts of conservation groups, it has not been possible to stop the cutting of virgin lowland forests in the southern states that appear to be necessary habitat for the ivory-bill. Destruction of those forests seems to be the main factor responsible for continuous

decline in the numbers of this species, which is given complete legal protection.

Sandhill cranes, egrets, certain other herons, pelicans, and several species of ducks and geese, the antelope, and a few kinds of deer and elk, among those whose extermination was deemed certain, have made a very decided recovery from their lowest numerical status. In this restoration, refuges—private, state and federal—have played an important and in some cases a decisive part. There is no question that small nucleus herds of threatened deer and antelopes were preserved and given a chance to recover to their present numbers by the safety afforded by refuges, chiefly private and state.

State refuges are of all types and sizes and are often used for a variety of purposes. The use of refuges in game management has been increasing in state programs. Illustrations of such management are refuges established for a definite term of years. These are customarily located in depleted game districts with the expectation that protection will restore game populations. If the depletion is a result of overhunting, the results are usually satisfactory, but if the scarcity of game is due to destruction of habitat, closure alone may not remedy the situation.

A growing number of states are building their game-management programs about widely scattered refuges. These reservations may be planned as permanent on lands owned or leased by the state, or they may be areas administratively closed to hunting. These programs are mostly too new to permit a fair judgment of their value. Some of those intended to conserve ring-necked pheasants and quail have apparently been successful. The basic idea is that small scattered protected areas will preserve breeding stock, which after the hunting season will spread naturally to surrounding favorable coverts, or which may be trapped and transferred to depleted sections. In Ohio this technique has been successful in maintaining pheasant populations despite heavy hunting pressure. Not only does the natural production remain at a comparatively high level on the refuges but the birds trapped there and released elsewhere show a much higher percentage of survival than do pen-reared birds.

Pennsylvania, which now owns some 687,000 acres of state game lands, has used refuges as management tools extensively, particularly in its recent farm-game program. Other states also have adopted the method and there are few successful game-

restoration programs in which refuges or closed areas do not play an important part.

The same idea has been applied to fish management and closure of a stream or lake for a definite period is now a recognized method of restoring a depleted fishery. Sometimes sections of streams are alternately opened and closed, thus preventing overfishing of the entire stream in a single season, yet minimizing local objections of fishermen over losing their sport while angling is still permitted in other localities.

In this treatment of state refuges it should again be emphasized that a refuge not properly posted and protected is no refuge at all. Rather it tends to become a more or less exclusive hunting ground for the petty criminals of the community. Law-abiding citizens respect the closure, while those less scrupulous take advantage of it.

These remarks apply to vast refuges established between 1910 and 1925 in western states. A number of these have never been posted or adequatedly patrolled, hence have done little good. They may have protected some game by keeping down the intensity of hunting, but, on the other side, they have aroused resentment among the more responsible citizens in proportion to the extent that the lawless element failed to respect them. Such paper refuges have other bad effects. Often their presence on a map creates an entirely erroneous impression that greater protection is being given than is the case. A feeling that all is well with the wildlife population may result when actual investigation might reveal the opposite. More important, the mere existence of these paper refuges is often used as an argument to block effective game or wildlife restoration. The vast acreage now in such refuges is frequently pointed to by opposing interests as evidence that game is already amply protected. It seems unquestionable that the sooner such paper protection is removed and management substituted the better for wildlife.

A questionnaire sent to all the state game departments in the spring of 1941 brought forth an amazing amount of information on state refuges and their present status. It had been hoped that some tabular summary of the material might be made, but that appears impossible. Refuge concepts vary so widely that statistical rating of refuge effort might be grossly unfair. Refuges should be judged from only one point of view—are they doing the job for which they were established? If so, number, size and distribu-

tion are of secondary importance. It has seemed best, therefore, to summarize briefly the present status of the refuge system by states. Before doing that, it seems worthwhile to outline certain general conclusions from the information collected.

The historical part of the data is admittedly fragmentary. State game departments have been so often subjected to wholesale changes of personnel that there has been too little continued record keeping. The absence of any item in the information here given for the various states probably means that present records are deficient in that particular.

In general the states have been more mindful of resident than of migratory game. This has resulted from the trend of game depletion. The larger forms of game have always been the first to go and the earliest game laws were for the protection of deer and turkeys. Smaller resident game species were next affected, while the migratory waterfowl were the last to decrease rapidly. Further, there was not the same sense of responsibility for the migrant as for the resident game.

It may appear that game species are entering too much in this discussion of refuges but the fact remains that with the exception of plume birds, species that have at some time been considered game have largely furnished the need and the impetus for both the refuge and the general conservation programs. Nearly all the species that have been exterminated or greatly depleted have been those sought for sport and food.

In the light of these facts and the further fact that state refuge protection and development have been largely financed out of receipts from the sale of hunting and fishing licenses, greater attention to resident game was inevitable. The need for such attention was most apparent, and one commonwealth could build up its local resident game regardless of the conditions in neighboring states. In the West, vast big-game refuges were favored while in the more thickly settled East smaller areas for lesser species were popular. The programs advanced more rapidly in northern than in southern states for two reasons: (1) the depletion of game was more serious and consequently the need was greater; and (2) conservation sentiment was more vocal and better organized.

State game administrators have learned some general truths about refuges that have also become apparent to those in the federal service. One of them is that marsh and lake restoration

successful in attracting numbers of water birds is more impressive to the public than an equally meritorious project for the conservation of deer or quail or grouse. The comparatively secretive habits of most of our upland game make it difficult for the average untrained observer to appreciate even an outstanding job in restoring them. On the other hand, the waterfowl are so much in the open that they are easy to see. The Fish and Wildlife Service realized several years ago that the development of marshes or lakes, even on the big-game refuges, not only increased their wildlife utility but made it much easier for the public to understand their value.

A growing number of states have independently developed similar procedures, with the result that, judged by their all-around value to wildlife, an increasing number of their refuges are in the first rank. Utah, South Dakota, Wisconsin, Indiana, Iowa, New York, California and Washington are among states that have developed refuges of this type. Pennsylvania has only one state waterfowl refuge—Pymatuning Lake—but acre for acre it ranks with the best in the country. Horicon Marsh, a joint federal and Wisconsin state restoration project, will be one of the greatest wildfowl and muskrat projects in the country when completed, and its incidental production of pheasants will give it high rank in that field. Utah has been outstanding in developing marsh-restoration projects. Oregon's Summer Lake will be as good as any when completed. California has several excellent marsh and lake areas, two of which it has been my privilege to visit. Indiana has restored some small units of the famous Kankakee marshes with excellent results; Iowa's Rice Lake project is a small marsh restoration that could with advantage be many times imitated in the northern Mississippi Valley states; New York has two excellent small waterfowl areas; and there are a number in the Dakotas.

There are many others but enough have been mentioned to show the growing popularity of such developments. With proper planning it is often possible to develop or add fishing values to those of upland game and waterfowl production and thus insure additional returns. The projects submitted for the Federal Aid to States program reflect the growing appreciation of the advantages of multiple-use, over more specialized, areas. However, this type of restoration should never supplant restoration of environment for special purposes.

There is a tendency also to reduce the size if not the number of big-game refuges, particularly in the western states where big-game populations have grown to the point where the hunting kill is no longer great enough to keep the herds of deer and elk in balance with the available food supply. This tendency is also sound, provided it does not go too far.

The latest development in the state refuge program has been the scattering of numerous small refuges with good food and cover for small game throughout farming districts. An increasing number of the agricultural states are using this plan. It has been successful in northern Ohio in maintaining a shootable surplus of ring-necked pheasants and is a vital part of the Pennsylvania farm-game plan. The greatest difficulty seems to be that of patrol; however, in a community favorable to the idea, the refuges need little policing. Automatic restocking is the objective sought and if a practicable means of attaining it with other species can be developed and methods of patrol and maintenance at moderate cost can be found, there is little question that a greater production of game can be obtained at a lower cost than with more artificial systems. It seems to be a sensible attempt to work with Mother Nature. It may be regarded as a profitable modification of the refuge concept to meet a pressing game-management problem.

The following brief summary of the status of refuges in various states is largely as of March 1941, although some of the data were received somewhat later in the year. No federal refuges nor national parks are mentioned in these statements, although refuges established by state action on national forests, grazing districts, and the public domain are included. The acreages are usually estimates.

ALABAMA

Since 1907 all of the number 16 sections of land originally reserved and still belonging to the state, comprising a total of some eighty sections scattered over the commonwealth, have been game sanctuaries by legislation. The state has ninety-four upland game refuges totaling 66,000 acres, and four big-game refuges comprising 49,000 acres, but no refuges in either class for migratory waterfowl or non-game species. There are from 100 to 150 private sanctuaries in addition.

ARIZONA

All shooting or trapping is prohibited on state refuges, although permits are sometimes issued to trap predatory animals that may be causing trouble. Arizona's first refuges were established by legislative enactment in 1917 when four huge wildlife reserves, totaling 1,066,210 acres were set aside. At present there are approximatly 2,000,000 acres of land in seventy-three refuges.

ARKANSAS

Arkansas's first game refuge was the Bitter Creek State Game Refuge No. 1, created September 12, 1927, containing 3030 acres. At present there are eighteen upland game refuges comprising 341,140 acres. All species of birds and mammals—game or non-game—are protected on these areas at all times, with the exception of predators which are controlled when necessary.

CALIFORNIA

California's first refuge was Lake Merritt at Alameda, which was established March 18, 1870. On March 28, 1878, Mt. Diablo, for three miles about the summit, was also made a refuge. The forty-two all-purpose upland game refuges at present maintained by the state contain 2,478,420 acres. There are also four excellent migratory waterfowl refuges totaling 9216 acres.

COLORADO

The first refuge was established in 1921. At present there are twenty-nine refuges, containing 3,781,920 acres. In addition there are several areas closed for definite terms of years.

CONNECTICUT

No sanctuaries are listed in the reports of the State Board of Fisheries and Game prior to 1922, so it is not known when the first one was established. At present two refuges for both migratory waterfowl and upland game contain 7720 acres.

DELAWARE

Delaware established its first refuges in 1937. At present there are two for migratory waterfowl containing 390 acres, nineteen for upland game with 6971 acres, and two for non-game species comprising 420 acres. On two refuges, namely Mill Creek, Newport (125 acres), and Russell Woods, Lewes (40 acres), birds of prey are specifically listed among the forms protected.

FLORIDA

The first state refuges were authorized by legislative enactment in 1927. Several were set up immediately and by 1938, thirty-six refuges and breeding grounds had been established. At the present time there are 136 state game-breeding areas containing more than 2,000,000 acres; these are principally for quail, turkey and deer, but all other forms of wildlife are also protected.

GEORGIA

There are no refuges maintained by the state but it helps patrol national forest management areas of 100,000 acres and the Okefenokee National Wildlife Refuge.

IDAHO

Payette Game Preserve, the first refuge, was established by the legislature in 1909. All game animals, game birds and fur bearers are protected on this refuge, which includes 345,600 acres on the Boise National Forest. There are two migratory waterfowl refuges of 1340 acres, fifty-eight upland game areas containing 562,720 acres, and twenty-two big-game refuges comprising 2,627,200 acres.

ILLINOIS

The first Illinois state game refuge was the 3000-acre Horseshoe Lake Game Refuge at Cairo, established in 1927, primarily for migratory waterfowl. In addition there are 600 upland game refuges on leased lands totaling 120,000 acres.

INDIANA

All of Indiana's forty-four state properties are wildlife refuges. Clark County State Forest, 1411 acres, set aside in 1903, is the oldest of these. The first state game preserve was established in 1924 in Brown County and consisted of 11,306 acres. There are now forty-four dual-purpose state properties, including state parks, forests, game farms, preserves and fish hatcheries, which are refuges for all forms of wildlife. Their classification includes three primarily for migratory waterfowl (9363 acres), one for upland game (11,306 acres), and twelve for big game (103,194 acres).

IOWA

Iowa's first state game refuge was established September 10, 1925, at Round Lake. It is a 450-acre sanctuary for migratory waterfowl and fur animals. The state now maintains thirty-nine refuges for migratory waterfowl, sixty-six for upland game, and fifty-seven as fur-animal refuges, the total acreage being 25,724. All forms of wildlife are protected.

KANSAS

Kansas created twenty general refuges in 1925. At present it has twenty migratory waterfowl refuges with a total of 2000 acres, and twenty upland game refuges comprising 20,000 acres.

KENTUCKY

Kentucky's first game refuge was set aside in 1919. It included some 40,000 acres between the Cumberland and the Tennessee rivers and was primarily for the protection of deer and wild turkeys, although all other species were protected. It is now a part of the Kentucky Woodlands National Wildlife Refuge. The state has nine game refuges totaling some 130,000 acres on which all forms of wildlife are protected.

LOUISIANA

The first state refuge was established November 4, 1911, in Vermilion Parish. It consisted of 13,000 acres donated to the

state. The state now has five migratory waterfowl refuges totaling 250,000 acres. These include the Rockefeller and Sage Foundation lands, which were turned over to the state for administration.

MAINE

The first refuge of 800 acres on Mt. Kineo was set aside in 1917 to protect big game. The state now maintains an extensive system of refuges on which all wildlife is protected. There are sixteen areas (14,047 acres) of primary importance to migratory waterfowl, four (6460 acres) for upland game, thirty-three (280,660 acres) for big game, and two (229 acres) for non-game forms.

MARYLAND

The first state refuge was created in 1921 on 3000 acres in Garrett County. This was leased land and, as the property is no longer under lease, the refuge has ceased to exist. At the present time the State Game and Inland Fish Commission owns ten state reservations containing 6542 acres, has under lease seventy-five refuges of 33,309 acres, and operates nine units on state forestry property embracing 2683 acres. The total acreage is 42,534.

MASSACHUSETTS

The first refuge was on Martha's Vineyard; it consisted of 600 acres, purchased in 1908 to preserve the heath hen—an objective which unfortunately was not attained. At the present time the state maintains twenty-two upland game refuges containing about 20,000 acres, and eight refuges for non-game species comprising about 1200 acres. These vary in size from 2 to 360 acres. Three of them are small islands with breeding colonies of terns and gulls, and five are tracts of from 110 to 360 acres for the protection of small birds. Massachusetts deserves special mention as one of the few states to establish refuges for non-game species, although many states protect such species on general-purpose refuges.

MICHIGAN

Michigan has a fine and well-patrolled refuge system. The first area, the Hanson Refuge, was reserved in 1916 and includes

PLATE 29

OUR NATIONAL FORESTS FURNISH HOMES FOR MANY OF OUR REMAINING HERDS OF BIG GAME

Upper. Deer in the Kaibab National Forest.

U. S. Forest Service photograph by E. S. Shipp

Lower. Shipping fawns from the Pisgah Fawn Nursery in Pisgah National Forest.

U. S. Forest Service photograph by Clint Davis

PLATE 30

OUR NATIONAL PARKS ARE ALSO REFUGES ON WHICH ALL WILDLIFE FINDS PROTECTION

Upper. Mount Rainier National Park.

Department of the Interior photograph

Lower left. Golden-mantled squirrels are always favorites with park visitors.

Photograph by Joseph S. Dixon, Crater Lake National Park

Lower right. Grizzlies in Yellowstone Park.

Photograph by Joseph S. Dixon

18,129 acres. At present the state has seven refuges for migratory waterfowl, comprising 11,900 acres; 279 for upland game totaling 79,562 acres; and four for big-game refuges with 34,122 acres. The state protects all non-game species on all refuges. There are seventy-four state parks consisting of 37,850 acres, which are also refuges for all forms of wildlife.

MINNESOTA

The Superior State Refuge, consisting of 1,290,000 acres of land, established March 22, 1913, by legislative enactment, was Minnesota's first. The state now has 188 refuges totaling 3,335,505 acres upon which all wildlife is protected. Minnesota has a law that might be well copied by other states. It prohibits shooting of migratory waterfowl on open waters, thus closing to shooting some 3,000,000 acres of the central waters of its lakes.

MISSISSIPPI

The first refuge was established in November 1932, two months after the State Game and Fish Commission was formed. It was set aside for quail protection. At present the state has forty refuges of about 230,901 acres. These are partly on state land and partly on privately owned lands leased for refuge purposes. Some of these have been rented for definite terms of years only and may later become hunting areas.

MISSOURI

The first refuge area was the grounds of the Sequiota State Hatchery near Springfield, purchased in 1925 and closed to all hunting. Seven other areas were acquired during the same year. At present Missouri has two refuges for migratory waterfowl containing 1606 acres, one for prairie chickens of 1800 acres, and thirteen for deer and turkeys with 112,257 acres. These include eight refuges of 74,000 acres on Forest Service purchase units. In addition, the Missouri Conservation Commission has established the following coöperative game refuge-management units since 1938: seven areas for turkeys and deer, 90,600 acres; three for waterfowl, 3300 acres; six for prairie chickens, 28,935 acres; thirty for farm game with controlled shooting, of 264,938 acres;

three for fur bearers, 11,000 acres; and four for songbirds, 1166 acres.

MONTANA

The Snow Creek Preserve of 217,728 acres, established by the State Fish and Game Commission, is the earliest record that has been furnished for Montana. At present there is a system of refuges, created partly by legislative act and partly by the State Fish and Game Commission action, that embraces nineteen containing 495,787 acres, chiefly valuable for game birds, and forty with a total of 3,225,640 acres primarily for big game. Some of these are on private holdings, others on national forests, and some are on state-owned land.

NEBRASKA

The Garden County game refuge, 7000 acres, created by an act of the state legislature in 1925 for the better protection of birds and the establishment of breeding places therefor, was the earliest. It includes all that portion of the state of Nebraska for ten rods on each side of the North Platte River in Garden County. The state also has four migratory waterfowl refuges, containing 95,000 acres, and one big-game refuge of 800 acres. In addition, no shooting is permitted on seven state parks of 1580 acres, and thirty recreation grounds of 6431 acres.

NEVADA

The first refuge was set aside April 9, 1923; it consisted of a township surrounding the Lehman Caves in eastern Nevada. The state now has nineteen refuges defined in proclamations by the Governor but none is adequately posted or maintained.

NEW HAMPSHIRE

The first game refuge in New Hampshire was established in Hillsboro on August 12, 1922. It comprises 375 acres and protects all forms of wildlife. At present there are ten refuges that may be classified as follows: seven for upland game of 6497 acres, two for big game with 2800 acres; and one for non-game birds of 97 acres. All forms of wildlife are protected on these areas.

NEW JERSEY

The first game refuge was created October 3, 1916. It included 5000 acres known as Buttonwood Park in Warren County and was held as a game refuge until October 3, 1931. Several others also were established but later abandoned. At present one of 1000 acres is maintained under the refuge law passed on March 31, 1916. There are also sixteen refuges for upland game in Warren County, comprising 261 acres, and fifteen in Somerset County totaling 216 acres. These are small refuge plots established under the provisions of the Pittman-Robertson Act.

NEW MEXICO

The earliest game preserve was the La Joya Game Refuge established August 13, 1921 for migratory waterfowl. It consisted of 600 acres in the Rio Grande Valley. The state now has twenty-one refuges containing 69,312 acres for migratory waterfowl, eighty-six of 720,466 acres for upland game, and ninety-four totaling 2,515,959 acres for big game.

NEW YORK

The first big-game refuge was set aside at North Pharsalia and consisted of 4200 acres. The state now has two refuges for migratory waterfowl of 4200 acres; ten for upland game, with a total of 60,000 acres; and three for big game of 1700 acres. The respondent to the questionnaire commented that only about 25 per cent of this land is actually posted and maintained.

NORTH CAROLINA

Mt. Mitchell Big Game Refuge of 3,000 acres was the first one established; date not given. At present the state has two refuges for upland game comprising 104,000 acres, and nine for big game with 352,980 acres.

NORTH DAKOTA

North Dakota has five state-owned refuges with a total of 5020 acres, all but one of which have been at least partly purchased and developed with Federal Aid funds. These are for small upland game, although one has value for migratory waterfowl as well

and one also protects white-tailed deer. In addition this state has 965 areas of privately owned lands, containing 304,366 acres, temporarily closed to hunting.

OHIO

The first game refuge probably contained not more than 200 acres and its name is now unknown; it was established for upland game in 1915 in Delaware County. The state maintains five refuges of 4394 acres for migratory waterfowl, 669 areas in private lands (98,277 acres) for upland game; and one big-game refuge of 9000 acres. State forest parks, numbering twelve and consisting of 5204 acres, not under administration by the Division of Conservation, protect both game and non-game species, and the Ohio Archaeological and Historical Society prohibits hunting on thirty-four areas under its control, comprising 14,138 acres.

OKLAHOMA

Oklahoma's one big state-owned refuge, established in 1918, consists of 15,000 acres near Broken Bow. In addition the state has 747 leased upland game refuges, embracing 298,863 acres. There are no special reservations for migratory waterfowl but at least ten of the upland game refuges are used extensively by these birds as resting places.

OREGON

The first refuges created by legislative act in 1913 included five upland areas and one lake which together contained 1,195,440 acres. At present there are twenty-eight reserves established by legislation consisting of 3,233,885 acres, and sixteen private refuges (by agreement with the Commission) of 20,908 acres. These protect all wildlife.

PENNSYLVANIA

The first state refuge established in Clinton County in 1905 consisted of 2002 acres. The state now has one refuge for migratory waterfowl of 3670 acres, 266 primarily for upland game consisting of 121,529 acres, and seventy-three auxiliary refuges total-

ing 14,207 acres. Pennsylvania has about 687,000 acres of game lands owned by the State Game Commission, not all of which is used for refuge purposes but which can be so used if need arises.

RHODE ISLAND

Rhode Island has a law prohibiting hunting on all state-owned land—forty-seven areas, totaling 7721 acres.

SOUTH CAROLINA

This state maintains no refuge for any form of wildlife.

SOUTH DAKOTA

The first refuge, Custer State Park set aside in 1913, consisted of 61,440 acres. The state also maintains a comprehensive refuge system for all kinds of wildlife. Many of the areas serve more than one purpose: forty-eight comprising 39,193.77 acres are considered primarily of value for migratory waterfowl; twenty-seven totaling 219,993 acres are especially for such upland game birds as prairie chickens, sharp-tailed grouse and ring-necked pheasants; and two, containing 172,500 acres, for upland game in general.

TENNESSEE

An area of 5000 acres on and adjoining Reelfoot Lake was set aside as a refuge in 1932, with the special purpose of protecting deer, turkeys, raccoons and squirrels. At present the state has eight refuges for migratory waterfowl with a total of 8000 acres, and twenty-nine for big game containing 304,703 acres. No fewer than 4500 units, with a total of 492,000 acres, are refuges leased from private individuals for five- or ten-year periods. Their use is considered as an experiment in wildlife management.

TEXAS

The first refuges were established in 1925 but there are no data available as to their size. The state now has forty-one wildlife preserves containing 2,244,371 acres, on which all forms of wildlife are protected. No restoration or development is being done on these closed areas.

UTAH

The public shooting grounds west of Corinne was the first bird refuge. It was developed in 1923 to provide nesting grounds for redheads. The state maintains seven areas for migratory waterfowl, consisting of 350,000 acres, some of which are at times open to shooting, and ten refuges for upland game containing 8000 acres. A number of the migratory waterfowl projects have involved restoration of old marshes or the establishment of new ones. The first Pittman-Robertson project approved in the country was for one of these restorations near Ogden. Its development removed a dangerous source of western duck sickness (botulism) and replaced it with a wholesome, productive marsh.

VERMONT

The first reservation at Waterbury, October 25, 1916, consisting of 125 acres, was an all-purpose refuge. The state now maintains one refuge of 900 acres for migratory waterfowl, and fourteen for upland game totaling 4695 acres.

VIRGINIA

The first refuge at Boulevard in 1920 consisted of 1284 acres. It was used as a game farm but was also a sanctuary. The state now has twenty-five refuges for upland game birds and big game, totaling 119,446.65 acres. There are also nine refuges for nongame species comprising 7273 acres. These vary in size from 106 to 1336 acres and consist largely of the grounds of state institutions where all shooting is prohibited.

WASHINGTON

The Sinlahekin reserve of 35,600 acres, established in 1913 for the protection of deer and upland birds, was Washington's first refuge. At present there are eight refuges for migratory waterfowl totaling 39,230 acres, and the closure along the Snake River and Columbia River (for waterfowl only) of 217,800 acres. These figures include two federal refuges of 25,600 acres that are surrounded by state lands. There are thirty-six refuges for upland game comprising 37,105 acres, seventeen for big game of 854,230

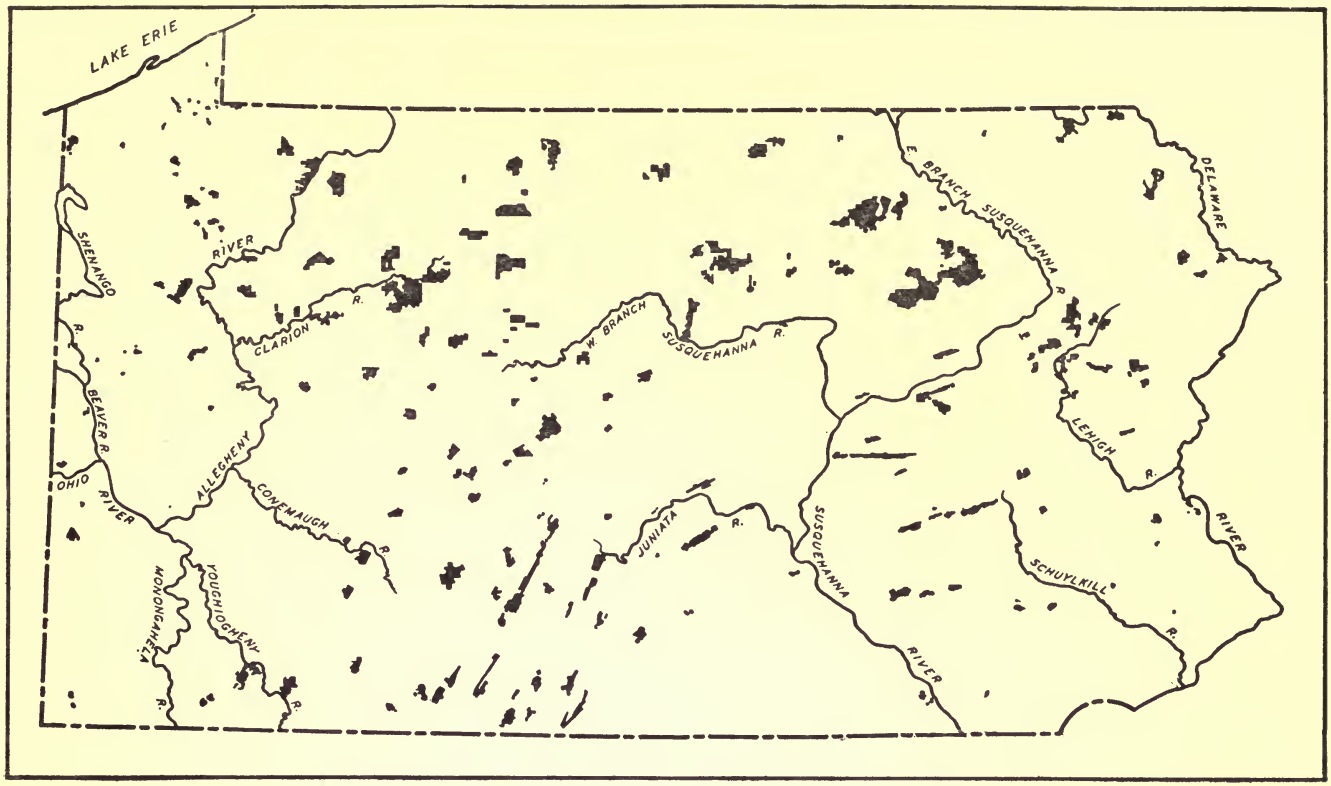

FIG. 12. Pennsylvania's State game lands are approaching an ideal distribution for their purpose. The solid black areas denote relative size of the units.

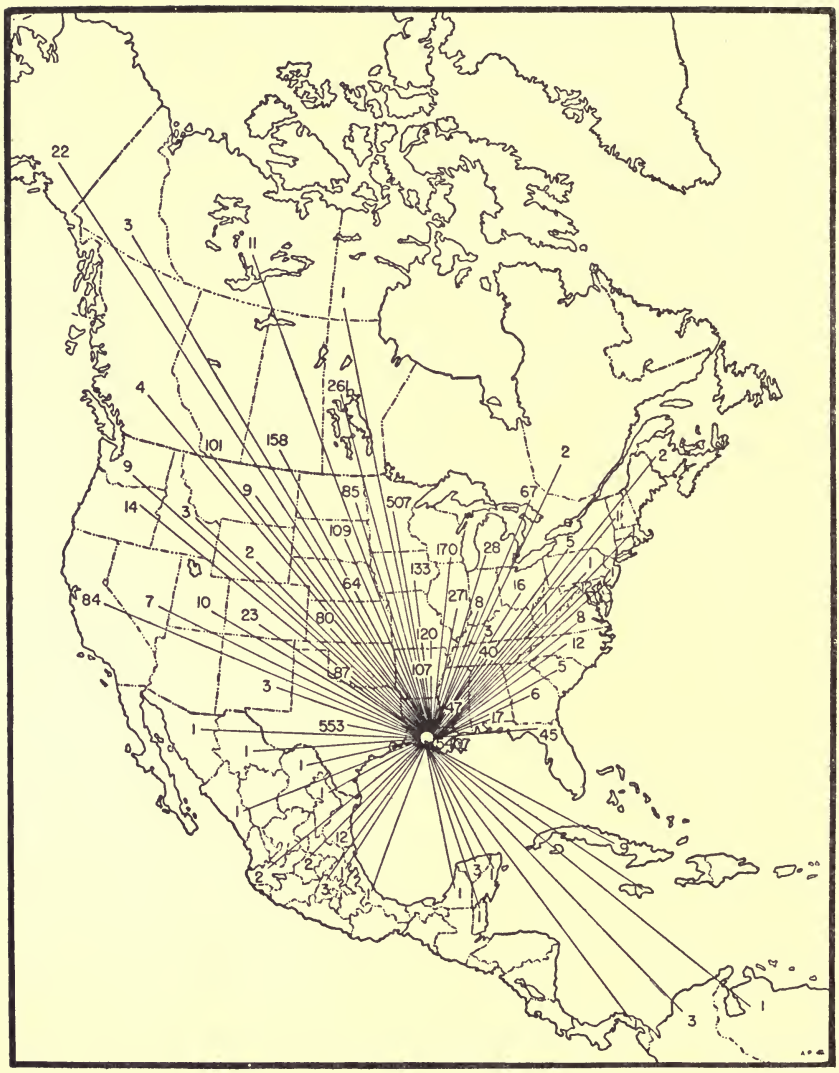

Fig. 13. Returns from ducks and geese banded at Avery Island, Louisiana. The marshes of Louisiana furnish winter homes for birds drawn from a vast area. Their preservation is a vital part of any continental waterfowl conservation program.

Fig. 14. Returns from ducks banded at the Kellogg Bird Sanctuary, a small refuge now operated by Michigan State College. It is a stopping place for migratory birds and the wide dispersal of birds banded there vividly illustrates the value of such refuges in furnishing food and resting grounds.

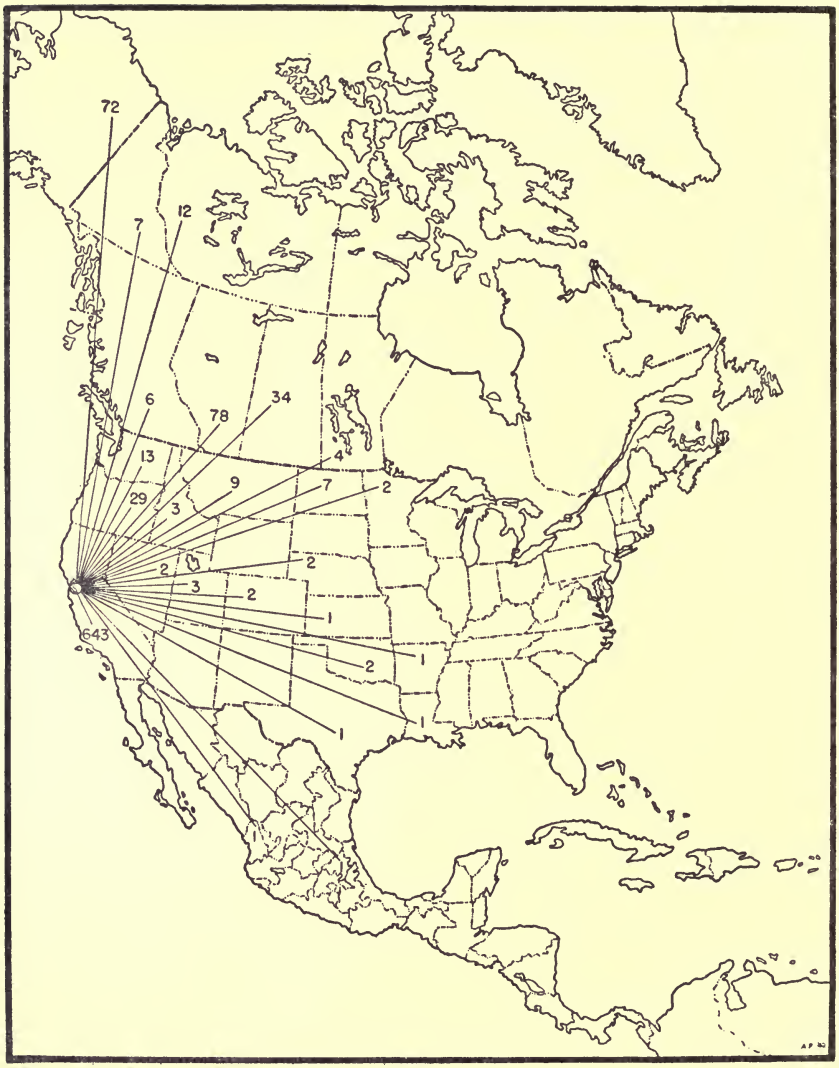

Fig. 15. Returns from ducks banded at Lake Merritt, California, a famous small wintering ground emphasizing the importance of the smallest wintering area which provides food and sanctuary.

acres. Some of these are open to deer hunting and one was opened to elk hunting in 1940. A total of 299,746 acres remained closed in 1940. In addition, there are five recreational areas containing 282,235 acres on which game is protected. The state does not own these lands but has closed them to hunting. Washington is now purchasing game lands with Federal Aid funds.

WEST VIRGINIA

West Virginia has four state game refuges designated as such, which contain 15,478 acres. In addition 59,457 acres in eight state forests and 32,525 acres in twelve state parks are also game refuges.

WISCONSIN

The first state refuge, comprising 46,080 acres, was created by legislative act; no date given. At present the state has twenty-five refuges for migratory waterfowl comprising 30,487 acres; 132 for upland game with 51,180 acres; eighty-four for big game, totaling 385,154 acres; and one for non-game species of 370 acres. This last-named area was set aside for the protection of sandhill cranes, several hundred of which use it each year. In addition, selected areas are closed each year primarily for the protection of grouse and deer. In 1940, 46,290 acres were thus closed.

WYOMING

Wyoming has at least nineteen State refuges set up by legislative enactment. They are State Game Preserves on which little or no hunting is permitted.

CHAPTER XVI

Private Refuges

This category includes wildlife refuges maintained by private individuals, conservation associations and by local governmental organizations—that is, by cities, towns and counties. Their number is legion and no complete list of them has ever been made. Such refuges vary from a site that may include little more than a city lot to areas that rival in size and effectiveness some of the best state and federal units. Many of them have their greatest value in the local demonstration of the effectiveness of intelligent protection and in the satisfaction they bring to their sponsors.

Frequently such refuges last only during the lifetime of the individual who founded them. Occasionally such an individual leaves an endowment sufficient to maintain the area as a refuge or gives it to some public agency. In recent years two refuges have in this way been added to the national system.

Although no full catalogue of this class of refuge has ever been made, the Conservation Committee of the Garden Clubs of America, in 1939, made a report on a survey of sanctuaries and nature trails which contains the best information now available. Eliminating federal and state units from the published list leaves 115 refuges in twenty-eight states. It is certain that this list is far from complete, but it at least conveys some idea of the variety and extent of this class of refuges. Some of those maintained by local governmental units were originally sponsored by garden clubs.

Many farms and ranches are closed to hunting or are so nearly closed by restricting shooting to a few individuals that they are game refuges in fact if not in name. Some of the great cattle ranches in various parts of the West thus saved herds of antelopes and deer but the best-known ones are in Texas where good stocks of deer, peccaries and wild turkeys owe their existence to the practically refuge status of the land. The latest big-game census lists a total of 1085 bison on private preserves.

Duck-hunting clubs, especially the larger ones, also treat part

of their lands as refuges where the waterfowl may rest and feed unmolested. To the extent that this is done, the club refuges compare in value to units under public administration. Their obvious weakness is that they depend upon personal action on the part of the owners who change from time to time, rather than upon law and settled public policy.

It is difficult indeed to name areas that typify the best in private and local refuges. Therefore this discussion will be confined to those that it has been my privilege to visit.

SMALL WATERFOWL REFUGES

Two of this type, which started as private refuges but later became public or served public purposes, come to mind. One is the Andrew Clark Refuge at Santa Barbara, California. Only forty-five acres in area, it was established in 1928 by private citizens but is now owned and supported by the city. An amazing variety of water birds frequent this small fresh-water pond that lies close to the ocean. It is a fine example of a wildlife display developed and maintained at very moderate cost.

The other is the W. H. Kellogg Bird Sanctuary near Battle Creek, Michigan. This 500 acres of land and water, originally made a refuge in 1927 by W. H. Kellogg, is now owned by Michigan State College. This sanctuary has become well known because of the studies of waterfowl carried on there. It has been outstandingly successful in attracting migratory waterfowl in number and variety. Permanent personnel is maintained, paid in part from the income of a trust fund established by Mr. Kellogg and in part from college funds. These men carry on research and also provide educational material and information for the visiting public. As the area has developed in recent years, it is much more than a refuge; it is an increasingly effective conservation-education center of a greatly needed type. One could wish for scores of such institutions for every one that exists today.

SONGBIRD REFUGES

The bird sanctuary at Fairfield, Connecticut, now guarded and maintained by the State Audubon Society, was established by Miss Annie Burr Jennings in 1914. Although it contains only ten acres, it is frequented by an amazing variety of small birds. It

includes an excellent small museum exhibiting specimens of the more common Connecticut birds and mammals as well as some of the rarities.

A refuge at Portland, Oregon, is both larger (thirty-four acres) and newer; it also has a resident warden who carries on educational work. One of the attractions of this area, owned by the Oregon Audubon Society, is a grove of virgin Douglas firs and a beautiful stand of hoary old Oregon maples. Many small birds and mammals are resident and the list of casual vistors is increasing constantly.

Small songbird refuges can be established and maintained at a minimum cost. The first and most important requirement for their success is the genuine interest of one or more persons. They can be installed almost anywhere, for few areas are so barren that birds will not respond to their protection. The two cited, maintained by societies, are of the more ambitious type. Both areas are fenced, they have bird boxes and feeding stations, and have been planted to shrubs and various other plants to increase the quantity and variety of food. Many private grounds are protected by posting and by the vigilance of the occupants, and feeding stations and nest boxes placed for the attraction of birds. The number of such refuges is already great and is constantly growing as more people learn the pleasure to be obtained from so simple and inexpensive a hobby. All do good not only in bird protection but also as conservation demonstrations for their neighborhoods.

LAKE MERRITT

The most noted of the small wildlife sanctuaries maintained by local governments is in Oakland, California. Lake Merritt, the oldest legally established wildlife refuge in the country, is now supported and maintained by the city of Oakland. It has attained fame as a wintering ground for wild ducks. The principal visitors are pintails and canvas-backs, but many others drop in to partake of its bounteous fare and avail themselves of its protection. Baldpates and shovellers rank third and fourth in numbers but numerous other species occur, at least occasionally. To stand on the shore of this small body of water, entirely surrounded by the city, and watch the waterfowl come over the office and apartment buildings and tumble out of the sky, sometimes in ludicrous haste to reach the banquet spread for them, is certainly a novel

experience. Lake Merritt has become one of the most popular attractions in the bay district, it being not uncommon for hundreds of persons to gather and watch the behavior of the flocks of waterfowl that move in and out.

On January 17, 1929, E. W. Ehmann caught a European widgeon in a banding trap operated on Lake Merritt. Probably it was the same bird noted in several previous years but it had never before entered the trap. This banded bird was subsequently captured and released at the same trap on January 30, 1931, December 5, 1932, January 23, 1934, and February 6, 1935. Who among bird students would not like to know something of the journeyings of this Old World straggler in the intervals between its appearances in its California winter home?

HAWK MOUNTAIN SANCTUARY

This refuge, unique in objective, is spread out over some 1400 acres of mountain covered by small second-growth timber. It contains few of the elements that one associates with the usual wildlife refuge but for its special purpose it is ideal. In fact no other known spot would serve so well as this rocky ridge in eastern Pennsylvania.

For years this area was known locally as a shooting stand for killing hawks that follow the mountain range in their fall migration. Thousands were killed each year up until 1934 when Mrs. C. N. Edge of the Emergency Conservation Committee leased Hawk Mountain, obtained an option to purchase it, and declared it a sanctuary. It was later deeded to the Hawk Mountain Sanctuary Association, an organization formed to care for it.

It is probably the best place in the country to become acquainted with the raptorial birds in flight, and is becoming an increasingly popular resort of out-of-doors people in fall. These visitors take advantage of the unequaled opportunity to add to their knowledge of these interesting birds in this, the only wildlife refuge in the country maintained primarily for raptorial birds.

My only visit to the area was on a clear day November 16, 1941. This was well toward the end of the migration and yet during a few hours many individuals of seven species of hawks and in addition two golden eagles passed the lookout. A careful record of the migrations has been kept by the caretaker, the summarized results of which are interesting enough to warrant reproduction.

VULTURES AND HAWKS SEEN AT HAWK MOUNTAIN, PENNSYLVANIA

Species	1934	1935	1936	1937	1938	1939	1940	1941
Turkey Vulture	166	374	87	44	60	146	150	182
Eastern goshawk	123	293	177	49	9	26	11	21
Sharp-shinned hawk	1,913	4,237	4,486	4,817	3,113	8,529	2,497	3,909
Cooper's hawk	333	553	474	492	204	590	166	416
Eastern red-tailed hawk	5,609	4,024	3,177	4,978	2,230	6,496	4,725	4,700
Northern red-shouldered hawk	90	181	153	163	143	314	149	198
Broad-winged hawk	2,026	5,459	7,509	4,500	10,761	5,736	3,159	5,170
American rough-legged hawk	20	9	0	4	0	8	4	2
American golden eagle	39	66	54	73	31	83	38	55
Bald eagle	52	67	70	38	37	64	72	50
Marsh hawk	105	153	149	160	189	273	161	254
Osprey	31	169	205	201	124	174	91	201
White gyrfalcon	2	0	0	0	0	0	1	0
Black gyrfalcon	2	0	1	0	0	0	0	0
Duck hawk	25	14	36	41	24	38	25	44
Pigeon hawk	19	20	34	10	12	43	11	35
Eastern sparrow hawk	13	123	102	141	87	184	60	196
Unidentified	208	23	11	8	0	0	7	38
Totals	10,776	15,765	16,734	15,719	17,024	22,704	11,237	15,471

PLATE 31

MANY NATIONAL AUDUBON SOCIETY REFUGES SPECIALIZE IN PROTECTING THE SHOWY HERONS AND THEIR RELATIVES

Upper left. Glossy ibis, Lake Okeechobee, Florida.

Upper right. Snowy egret, Florida.

Lower left. American egret, Florida.

Lower right. White ibis, Texas.

National Audubon Society photographs by Allan D. Cruickshank

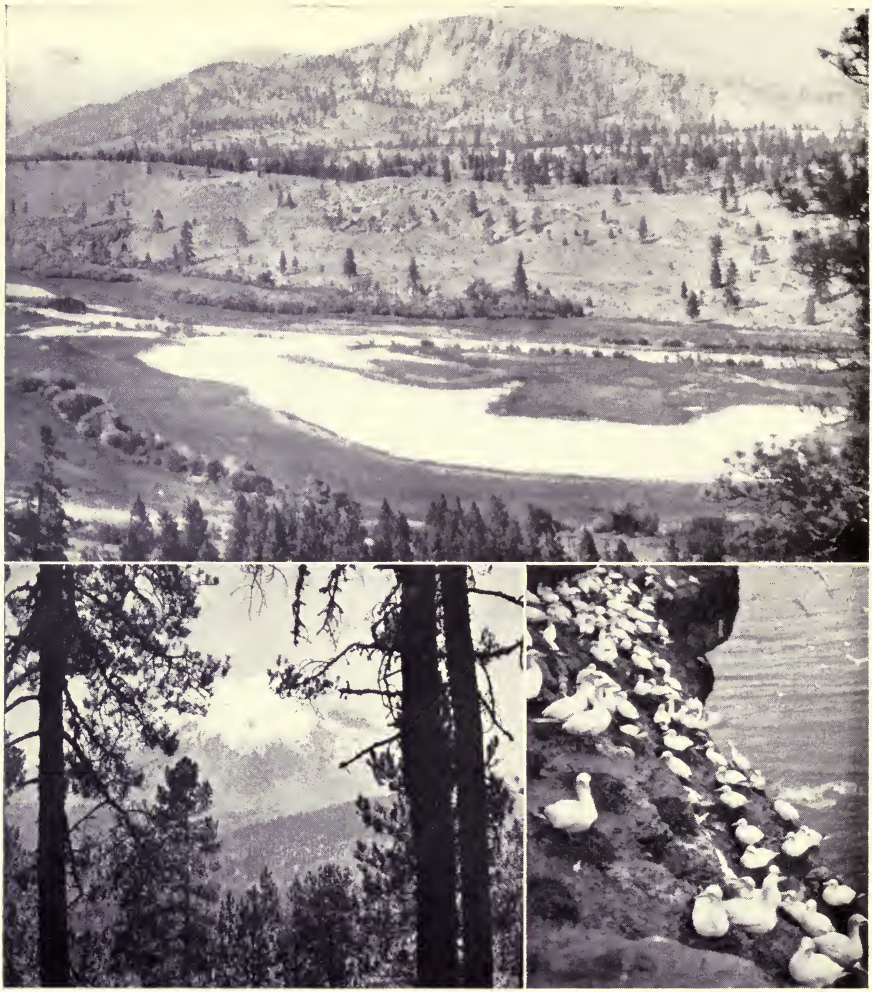

PLATE 32

CANADIAN AND MEXICAN PARKS AND REFUGES PROTECT WILDLIFE

Upper. Meadows in Vaseaux Lake Bird Sanctuary, British Columbia.
National Parks Bureau of Canada photograph

Lower left. Parque Nacional "Ixta-Popo," Mexico.
Mexican Parks Service photograph

Lower right. Gannets on Bonaventure Island Bird Sanctuary.
National Parks Bureau of Canada photograph by Harrison F. Lewis

BIRD CITY

The third oldest existing wildlife refuge, according to my information, is Bird City, at Avery Island, Louisiana. Established in 1892 and since maintained by E. A. McIlhenny, it is not only an outstanding wildlife refuge but is as unique in its way as is Hawk Mountain.

This is literally a bird city built by man but added to by natural accretions until it has become one of the most remarkable bird colonies of the continent. But Mr. McIlhenny should be allowed to tell his own story, which he does in the fascinating little book "Bird City." His account of the genesis of this unique colony is as follows:

> Among the many friends of my father and grandfather was an English gentleman who had been connected with the English government in India and later was Lord Mayor of London. Every couple of years he came from England to the United States and always came to see us to get some good shooting and study the birds and animals as he was a great lover of nature. He and I became very good friends and he told me many of his experiences with and observations of birds and animals in distant parts of the world.
>
> One of the stories that impressed me most was the story of the flying cages of Juraspore in India. As he told it, "About the middle of the Seventeenth Century there was a Rajah of Juraspore who was very fond of birds and animals. He caused to be built at his country place on the outskirts of Juraspore, a beautiful park in which he had built great cages of bamboo, and in them had suitable water areas and trees and had brought from other parts of India rare and beautiful birds and placed them in these great bamboo cages. They were taken care of carefully, and in time became tame, made their nests and reared their young. The Rajah grew old and finally passed on, and his cages were not taken care of, and in time rotted down. The birds who had been raised in these cages knowing the locality as "home" stayed on after the cages had fallen, and reared their young in the same place where they had been reared. All remnants of these cages have now disappeared but the flying gardens of Juraspore still exist and will continue to exist as long as the birds and the trees in which the birds live are not changed by man."

In the spring of 1892 Mr. McIlhenny decided to profit by the Rajah's experience. He built a dam around a small spring in which grew a few buttonwood trees and erected over it a flying cage of poultry netting some fifty feet square. After some effort he obtained eight young snowy egrets, brought them home and

fed them in the enclosure until they were fully grown. In the fall the cage was removed and soon afterwards the birds left. The next spring six returned and eventually two pairs successfully nested. From this small beginning the snowy egret colony grew. Other species of herons came in to nest, gradually forming the huge rookery that exists today.

THE NATIONAL AUDUBON SOCIETY REFUGES

Carrying on by far the most ambitious refuge program of any non-governmental group, the National Audubon Society maintains at present thirty-six sanctuaries in ten states. On these are stationed some twelve permanent wardens and ten part-time guards employed to protect rookeries of non-game birds during the breeding season.

Some of these areas are owned outright; others are leased or are patrolled by agreement with the owner. Regardless of differences in their legal statuses these refuges are important factors in the restoration and preservation of many of our non-game birds.

The largest single refuge owned by the Society is in Louisiana. Here the Rainey Wildlife Refuge was established, when 26,000 acres of land were given to the Society. It is near the Rockefeller and Sage Foundation Preserves operated by the state of Louisiana. Like them it is primarily a waterfowl refuge, furnishing winter food and safety to blue and snow geese and to a considerable variety of ducks.

By far the most important Audubon refuges are located in Florida where eight are maintained and in Texas where a total of seventeen are patrolled and preserved. In both states the birds chiefly protected are herons and ibises. In Florida great colonies of the white ibis, wood ibis, glossy ibis, snowy and American egrets, Ward's, little blue and Louisiana herons, and black-crowned and yellow-crowned night herons are guarded. Many other species also are protected, some of the most interesting of which are the Florida crane, Florida burrowing owl, Audubon's caracara, limpkin, everglade and swallow-tailed kites, gull-billed tern, anhinga, great white heron, and the rare roseate spoonbill and reddish egret. These latter two birds are now exceedingly rare in Florida, although still fairly numerous along the Texas coast.

The National Audubon Society tries to protect the shifting rookeries of herons and other erratic birds that may suddenly change from one breeding station to another, attempting to lease or otherwise control newly formed rookeries from their inception. It maintains patrol of such rookeries during the breeding season and in addition keeps a 36-foot cabin-cruiser on the southwest coast of Florida in which wardens inspect the vast complex of islands, streams and channels of this district.

During recent years special attention has been devoted to the roseate spoonbill in an effort to find a method of building up a larger population from the small remnant that now survives. It yet remains to be seen whether these efforts will succeed.

The nineteen Texas refuges are largely islands lying in shallow lagoons along the coast. Many of them are leased from the state. While some once-important areas have been deserted, the most spectacular bird colonies on this coast are still protected. The largest colonies of roseate spoonbills and reddish egrets known in the United States are present on these refuges. There are two large colonies of spoonbills or "pinks" which, in 1941, contained 234 and 500 nests respectively. Green Island usually has a colony of about 5000 nests of reddish egrets.

In addition, American and snowy egrets; Louisiana, little blue, and Ward's herons; black-crowned and yellow-crowned night herons; white and glossy ibises; white and brown pelicans; Caspian, royal, gull-billed, Cabot's, least, and Forster's terns; black skimmers; laughing gulls, western willets, fulvous tree-ducks and Mexican cormorants are found here. In 1941 there was a nesting colony of white pelicans, the only one known on the Gulf coast. The colony of Cabot's terns is the largest in the country.

Preserving these spectacular water birds is the greatest possible justification for these refuges and it is one of the most important activities, if not the most important, in the Society's refuge program.

The National Audubon Society also has two small island refuges off the Maine coast, protecting Leach's petrel, herring gull, great black-backed gull, and black guillemot colonies, American eiders, ospreys, and a variety of songbirds. The single refuge in New Jersey is at Cape May. Here on leased land the Society has been endeavoring to stop the shooting of migrating hawks which often accumulate here in numbers before starting off to

the southward across Delaware Bay. The lease on a portion of the property has expired and its future status is uncertain.

In New York, likewise, there is only a single National Audubon Society refuge—one for songbirds at Oyster Bay. A single island in the Susquehanna River near Lancaster is patrolled for the protection of bald eagles and incidentally of small birds; Buzzards Island, South Carolina, has a mixed colony of four species of herons; and Cobb's Island, Virginia, has long been famous for its nesting colonies of oyster-catchers, laughing gulls, black skimmers, and common, Forster's, gull-billed, least and royal terns, clapper rails, Wilson's plovers, and willets.

It is apparent from even this necessarily abbreviated discussion that refuges other than those maintained by federal and state governments play an important part in the conservation of many of our most interesting birds. While many songbirds thrive about the abodes of man, some perhaps being more abundant now than at any previous time, others have suffered through destruction of environment and have decreased in numbers. Some of these depleted species have now been given a chance through refuge programs to return to lands from which they had long vanished.

The official soil, water, forest and wildlife conservation programs are helping greatly and they are most successful in communities that have a good conservation background. One of the factors that has contributed to these backgrounds has undoubtedly been the presence of small refuges backed by local enthusiasts. More of these are needed. The refuge program, which has now become an accepted part of wildlife restoration, undoubtedly started with protection of private lands—and the protection of private and semi-private lands still occupies an important place in the conservation effort.

CHAPTER XVII

Canadian and Mexican Refuges

Some duck hunters complain that the United States is doing all the conservation for the benefit of neighboring countries to the north and south. It may interest them to know that poorly informed individuals in those countries say that the shoe is on the other foot. The more selfish Canadians have a "we raise them, you kill 'em" point of view regarding our country; this is offset in the United States by the attitude of those who criticize curtailment of hunting privileges in this country which they allege is of benefit only to Canada. Mexicans charge that we kill for fun while they kill for food, only, and that the greatest "game hogs" in Mexico are vacationing Americans.

Doubtless there are "game hogs" in each of these countries; the breed is not confined to any race or climate. The more intelligent people in countries bound by the migratory bird treaties, however, realize that preservation of the migratory flocks for the value they have as a source of food or of pleasure is a mutual responsibility, requiring effort, and perhaps sacrifice, by each nation.

CANADIAN REFUGES

Canadian restrictions on hunting are comparable with ours. It is true they are not identical but their purpose is the same. In some ways they are more stringent, in others somewhat less; but they are meant to conserve a stock more essential to certain elements of the Canadian population than to any of ours.

In providing refuges the Canadians have been as diligent as we. This is only what one would expect of two countries speaking the same language, reading the same magazines, and listening to the same radio programs. The surge of conservation sentiment that started to grow ever stronger at the turn of the century was not halted by the international boundary, but influenced public thinking and public action on both sides of the line.

Canada has national parks that are wildlife sanctuaries and a

system of wildlife refuges similar to ours. It is true that they have been established under somewhat different laws but, like our sanctuaries, they are effective to the extent that they are patrolled and protected.

Our first national park was established in 1872 while Canada's earliest did not come into being until 1885. Canada's first park, Banff, like ours set a high standard and is recognized as one of the superlative scenic areas of the continent. While we had a thirteen-year start, our northern neighbor had created two more parks, Yoho and Glacier, both in 1886 before our Sequoia and Yosemite were reserved in 1890. In 1895 Canada set aside Waterton Lakes, which we matched in 1899 by Mount Rainier. Both countries responded to the conservation crusade of the first twenty years of the century by establishing numerous national parks. During the 1920's there was a lag in both countries during which little progress was made, but in the late 1920's and through the 1930's the rate of establishing national parks again accelerated.

At the present writing, Canada has nineteen national parks exclusive of historical parks, with an approximate total acreage of 7,937,920; our total is twenty-six areas with an acreage of 10,321,331.50. We have an additional 11,000,000 acres in national monuments, historical parks and other areas under the National Park Service, for which Canada has only a few historical sites as a counterpart, but it seems evident, nevertheless, that their national park system compares very favorably indeed with our own.

I can speak from experience about only three Canadian parks —Banff, Yoho, and Kootenay—but I am sure that no park on our side of the border exceeds this group of three parks, lying across the backbone of the Rockies, in scenic splendor or as wildlife sanctuaries. All Canadian parks protect wildlife at all times as do our own. Animals finding refuge in the three mentioned include Rocky mountain sheep, mountain goat, mule and white-tailed deer, elk, moose, caribou and black bear. Waterton Lakes, Jasper Park, Glacier Park, Mount Revelstoke, Prince Albert and Riding Mountain are also outstanding big-game areas. Riding Mountain and Point Pelee are valuable for waterfowl as well as for other species. In addition to these reservations there are three fenced areas devoted primarily to the preservation of big game. The largest of these, Buffalo National Park, has 197½

square miles under fence and at one time carried some 3000 bisons, the largest herd on the continent. These animals have recently been killed off because of the prevalence of tuberculosis among them. After a quarantine period, the park will presumably be restocked.

Elk Island National Park has fifty-one square miles within its fences, which protect 2000 bisons as well as herds of elk, moose and deer, while the Nemiskam Park (8.5 square miles under fence) contains a herd of 125 antelopes built up from 42 animals that were confined to the area by the simple expedient of building the fence around the herd. All of the other parks contribute at least locally to the available food, cover and sanctuary for wild creatures. Here, as well as in our own country, the parks, although set aside primarily for other purposes, serve a useful function in the general continental program of wildlife conservation and restoration.

CANADIAN NATIONAL PARKS

Name	Province	Date Established	Area
Banff	Alberta	1885	2,585 sq. miles
Yoho	British Columbia	1886	507 sq. miles
Glacier	British Columbia	1886	521 sq. miles
Waterton Lakes	Alberta	1895	220 sq. miles
Jasper	Alberta	1907	4,200 sq. miles
Buffalo	Alberta	1908	195.5 sq. miles
Elk Island	Alberta	1911	21.2 sq. miles
St. Lawrence Islands	Ontario	1914	185.6 acres
Mt. Revelstoke	British Columbia	1914	100 sq. miles
Fort Anne	Nova Scotia	1917	31 acres
Point Pelee	Ontario	1918	6.4 sq. miles
Kootenay	British Columbia	1920	587 sq. miles
Nemiskam	Alberta	1922	8.5 sq. miles
Fort Beausejour	New Brunswick	1926	59 acres
Prince Albert	Saskatchewan	1927	1,869 sq. miles
Georgian Islands	Ontario	1929	5.37 sq. miles
Riding Mountain	Manitoba	1929	1,148 sq. miles
Cape Breton Highlands	Nova Scotia	1936	390 sq. miles
Prince Edward Island	Prince Edward Island	1936	7 sq. miles

Bird Refuges

The Canadian government maintains fifty-eight bird refuges which, according to the latest available figures, contain 819,237.2 acres. Famous Bonaventure Island and Percé Rock were among

the first of those still classed as dominion refuges to be established, on March 29, 1919—some sixteen years after Pelican Island was dedicated as our first national wildlife refuge. Like our first effort, it was set aside to protect non-game birds; the Bonaventure colony was gannets, ours brown pelicans. It remains a sanctuary today, and is a mecca for bird students who go there to study and photograph these masters of aerial navigation. Many of the smaller reservations protect breeding colony-nesting birds, while others are for migratory waterfowl. Of this latter type, three, grouped in the lower part of Hudson Bay, are the most important. These consist of Hannah Bay (1939), Twin Islands, Akimiski Island (1941), and Boatswain Bay (1941), all set aside to protect wildfowl, particularly blue geese which gather here in great numbers before starting their southward migration. These three refuges extend over a total of 800,000 acres and afford adequate protection for the migrating flocks. An additional section of Hannah Bay has also been closed by the Ontario provincial authorities, and it is included in the summary of provincial refuges.

Twelve areas in Saskatchewan totaling 473,000 acres and six in Alberta with a acreage of 133,587 were returned to those provinces under an act assented to on May 30, 1930. These refuges, established between 1920 and 1925 following the Migratory Bird Treaty, were largely for the protection of waterfowl, but are now a portion of the provincial system. Some of them are reputed to be outstanding breeding and resting areas for waterfowl and in addition furnish homes for many other marsh birds. It is interesting to note that a part of the Last Mountain-lake area returned to Saskatchewan in 1930 was made a breeding ground for wildfowl by an order in council dated June 8, 1887. This antedated our first federal refuge by sixteen years.

In addition to parks and refuges of the usual types, the dominion government maintains a number of reservations in the Northwest Territories that are unique in their conception. Five huge areas are reserved as exclusive hunting and trapping grounds for native Indians, Eskimos and half-breeds. In other words, no white person is permitted to take wildlife over approximately 587,997 square miles, which translated into acreage is a little matter of 376,308,080 acres. This is almost double the total area of our national forests, which comprise the largest public area reserved for any one purpose in the United States.

These vast Canadian reservations are:

Name	Date Reserved	Area in Square Miles
Arctic Islands Preserve	July 19, 1926	439,105 land area
Yellowknife Preserve	July 19, 1926	70,000
Slave River Preserve	July 19, 1926	2,152
Peal River Preserve	July 19, 1926	3,300 area in N.W.T. 4,000 area in Yukon Ter.
Mackenzie Island Preserve	May 3, 1938	69,440

In addition to these enormous reservations to protect the livelihood of the scanty population that lives on the Arctic Islands and the great barren grounds of the North, there are three others that require special mention.

The Thelon Game Sanctuary, created June 15, 1927, contains 15,000 square miles. All hunting and trapping is prohibited and its primary purpose is the preservation of the fast-vanishing muskox.

The Twin Islands Sanctuary, a part of the Hudson Bay system of migratory bird refuges, contains 35,200 acres. It was established May 2, 1939, and deserves further mention because it furnishes protection to a number of polar bears, which here are in the most southern part of their regular range.

Wood Buffalo Park, an area of 17,000 square miles, of which 13,375 square miles are in Alberta and the remainder in the Northwest Territories, is reserved for the bison. "Hunting and trapping is permitted only to those treaty Indians and half-breeds living the life of Indians who were resident in the park at the time it was established, and their children as they come of age, except in the area south of Peace River where those white trappers who were operating in the park when it was established are also permitted to continue hunting and trapping. Bison are protected at all times."

Provincial Refuges and Preserves

Most of the Canadian provinces, like the majority of our states, have established wildlife refuges and game preserves. Because of their various designations it is difficult to classify them. Some are big-game areas on which waterfowl and upland game are hunted and others are bird refuges on which big game may be taken in proper season; on still others all wildlife is entirely protected. It seems best, therefore, to list all of them simply as wildlife areas.

The following tabulation is based on the latest information obtained for me by the Lands, Parks, and Forests Branch of the Department of Mines and Resources.

Province	Number of Wildlife Areas	Acreage
Alberta	16	...
British Columbia	45	1,473,581
Manitoba	34	4,406,490
New Brunswick	9	695,040
Nova Scotia	4	323,520
Ontario	125	9,724,569
Quebec	5	14,079,360
Saskatchewan	78	...

Alberta

Alberta lists sixteen preserves or closed areas.

British Columbia

British Columbia has an extensive system including game preserves, bird sanctuaries and prohibited hunting areas. These last are closed each year by regulation and serve the same purpose as a game refuge so long as they are maintained. The acreage was not given for four areas so the figure of 1,473,581 is below the actual acreage.

Data available to me indicate that Victoria Harbor (22,400 acres) and Vancouver Harbor and English Bay (29,440 acres), established in 1913, began the provincial refuge system. Since that time it has grown to its present proportions without sudden expansion during any one period. So far as is known, Strathcona Park (1914) on Vancouver Island is the largest unit, containing 409,600 acres. Some of these refuges are obviously for big game while others just as certainly are for waterfowl, but they are not described in such way as to permit segregation.

Manitoba

Manitoba's provincial preserves are classified according to the varying regulations embodied in Schedules A to F.

Under Schedule A are sixteen areas comprising 1,263,890 acres. On these no hunting or trapping is permitted, making them sanctuaries for all species of wildlife. Schedule B covers three

FIG. 16. Canada's Dominion wildlife refuges are largely for colonial birds although some are for migratory waterfowl.

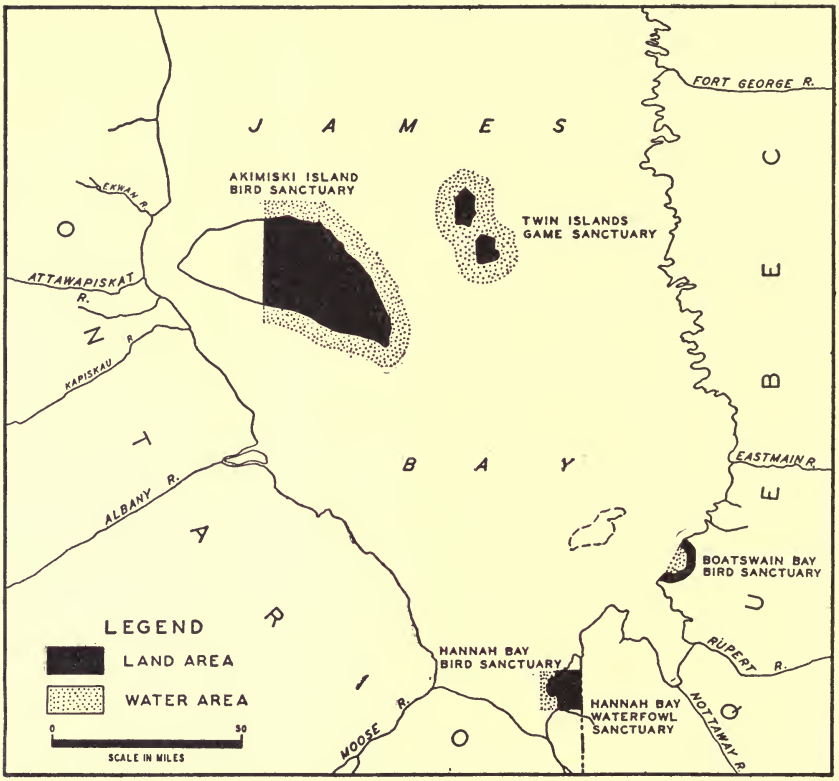

FIG. 17. Canada's refuge system on James Bay is primarily for the protection of blue geese and other waterfowl and was made necessary by the development of better transportation facilities into this formerly isolated region.

preserves containing 920,320 acres on which it is "unlawful to hunt game at any time except ducks, geese, chickens, partridge, and grouse in open season." In other words, these are big-game and fur-animal refuges. Schedule C includes a single unit of 149,960 on which big game cannot be hunted in odd-numbered years. We would class this as a management area on which a system of alternate open and closed big-game seasons is used as a management procedure. Schedule D applies to four tracts of 32,000 acres on which all hunting is banned but apparently trapping is permitted. Schedule E relates to three areas of 1,296,000 acres on which all game-bird hunting is prohibited but where big-game hunting and trapping are permitted. Schedule F governs one area of 63,680 acres that is closed to trapping and to all hunting except for ducks.

There are in addition six other areas of 680,640 acres closed to trapping, seasonly or permanently by orders in council, including one which is, in addition, closed to hunting of all groups except migratory waterfowl.

New Brunswick

New Brunswick has nine game refuges, all established for moose, deer and fur bearers between 1921 and 1939. They contain approximately 695,040 acres according to the latest available data.

Nova Scotia

Nova Scotia's four game sanctuaries, created between 1927 and 1938, protect all forms of wildlife.

Ontario

The Ontario refuges consist of 121 game preserves of 6,056,729 acres and four provincial parks of 3,667,840 acres. The units vary in size from 25 to 1,824,000 acres. All hunting and carrying of firearms for the purpose of hunting are prohibited so that these areas are sanctuaries for all wild creatures except fur animals unless otherwise specified. Some are for the protection of fur bearers alone, others for waterfowl only, but hunting is barred in most all of them. The first of these refuges was created April 24, 1923 and named the Falcon Game Preserve. It comprises 15,000 acres.

Quebec

Quebec permits no hunting on any of its 14,079,360 acres of parks, which are thus refuge areas with the exception that Indians may trap fur bearers on one of them. There are in addition three tracts of approximately 20,992,000 acres where Indians only are permitted to hunt.

Saskatchewan

This province has seventy-eight game reserves, many of them covering large areas of big-game lands and migratory waterfowl breeding grounds. An eighteen-page pamphlet is required to list their legal descriptions. So many fractional parts of sections and townships lying on each side of a river, railroad, or other boundary, are involved that attempts to tabulate the acreage without detailed base maps were futile.

Private Refuges

Little information is available regarding the number or extent of private refuges maintained in Canada, although they undoubtedly exist.

The Prairie Farms Rehabilitation Administration, financed by the dominion government, has been actively engaged in restoring marshes and ponds to the ultimate advantage of wildlife as well as human populations. Some of these areas are refuges in fact if not in name since for various reasons no shooting is permitted on many of them.

Ducks Unlimited, a private organization financed by American sportsmen, has been engaged in marsh restoration and improvement work in the prairie provinces since 1937. It has furnished funds for improvements on six provincial refuges, eight refuge areas under the administration of the Prairie Farms Rehabilitation Administration and three others maintained as refuges—one by the Mormon Church, one by private land owners, and one by the city of Portage la Prairie. These areas contain a total of approximately a half million acres, which are now better breeding grounds as a result of such improvements as water-impoundment structures, look-out towers, fences, patrol stations, fire guards, planting of food and cover plants and other miscellaneous projects.

Ducks Unlimited has carried out numerous other marsh-restoration and improvement projects not included in refuges but

which contribute directly to the welfare of the waterfowl population.

Mexican Refuges

The conservation crusade of the first quarter of the century affected our southern neighbor little if at all. Perhaps this was due in part to lack of necessity, for game and other wildlife have continued relatively abundant in Mexico to very recent years. There was little or no sport shooting by the native population. Such depletion as has occurred has been due to a relatively few visiting hunters who, all too frequently, threw off all restraint where no legal restrictions prevailed. In general the native population does not indulge in "sport" but confines killing to needs in procuring food. Wildlife can stand such a drain better than it can that of modern hunting with high-power rifles and repeating shotguns.

The opinion of Fish and Wildlife Service biologists following the migratory waterfowl to their winter quarters in Mexico is that, all things considered, the birds are safer in Mexico than in our own country.

Whatever may have been true of the past, conditions in Mexico are changing and the need for conserving natural resources is becoming increasingly apparent. It is to be hoped that Mexico will profit by our mistakes and set aside wildlife areas before their value is destroyed. While it is true that Canada and Alaska produce the bulk of the migratory waterfowl, it is equally true that Mexico and the United States must furnish food and proper living conditions to support the birds for half of the year if they are to survive. We are slowly, and at considerable expense, restoring our ruined marshes and drained lakes, and it is to be hoped that Mexico will reserve for all time the most important wintering grounds before exploiters by drainage or other devices destroy them.

That nation has already reserved as national parks forty-two areas, containing 549,468 hectares, or 1,357,187 acres. Of these only the unit containing the springs that furnish drinking water for Mexico City antedates 1935. This first area was purchased some time after 1876 and is now one of the national parks. These areas are preserved for their exceptional scenic values rather than for the wildlife that is present or which might exist upon them. Up to the present little money has been available to protect and

develop these parks but it is, nevertheless, a gain that they have been reserved.

The first of the new national parks is also one of the most spectacular, ranking well with any either in Canada or our country. This park, called "Ixa-Popo," contains nearly 250,000 acres and includes the great snow-capped volcanic cones of Ixtaccihuatl and Popocatepetl. Deep canyons and heavily wooded slopes contribute to the beauty of this, one of the most spectacular mountain parks in North America. It was established on October 29, 1935.

It is useless to attempt to discuss parks that I have never visited with anything approaching an understanding of their value and beauty. The appended list, condensed from one furnished by the Mexican government, therefore, must serve to indicate the progress in establishing parks in Mexico. I was privileged to visit one other park several years ago. It was the Lagunas de Zempoala, between Mexico City and Cuernavaca. Seven beautiful lakes along the flanks of a pine-clad mountain are the central feature of this exceedingly interesting area. If the remaining forty areas approach the two I have been fortunate enough to glimpse, the Mexican park system compares well in scenic beauty with those of her northern neighbors.

MEXICAN NATIONAL PARKS

Name	Date Established	Outstanding Features	Location	Area[1] Hectares
Ixta-Popo	Oct. 29, 1935	Ixtaccihuatl and Popocatepetl volcanoes		99,600
Nevada de Toluca	Jan. 15, 1936	Extinct volcano; lakes in crater	Mexico	67,000
Grutas de Cacahuamilpa	Jan. 20, 1936	Caves	Guerrero	1,230
Volcan de Colima	Jan. 20, 1936	Snow-capped active volcano	Colima	17,000
Cerro de Garnica	Aug. 10, 1936	High peak	Michoacan	968
Los Marmoles	Aug. 12, 1936	Forests	Hidalgo	23,500
Alejandro de Humboldt	Sept. 9, 1936	Forests	Guerrero	1,080
Insurgente Miguel Hidalgo y Costilla	Sept. 9, 1936	Historical site of battle of Las Cruces	Mexico	800
Fuentes Brotantes de Tlalpan	Sept. 9, 1936	Springs	Federal District	129
Cumbres del Ajusco	Aug. 26, 1936	Pine-clad mountain ridge and volcano of Xitle	Mexico, Morelos and Federal District	69,550
El Cogorron	Sept. 2, 1936	Artesian wells of hot water and curative properties	San Luis Potosi	25,000
El Potosi	Sept. 9, 1936	Semi-tropical forests	San Luis Potosi	2,000
Cofre de perote	Apr. 21, 1937	Mountains	Veracruz	11,707
Cerro de las Campanas	June 30, 1937	Scene of execution of Emperor Maximilian	Queretaro	58
Lagunas de Chacahua	June 30, 1937	Virgin tropical forest	Oaxaca	14,187
Molino de Flores de Netzahualcoyotl	Oct. 30, 1937	Hill of Texcutzingo, where are located historic baths of Netzahualcoyotl and the Hacienda Milano de las Flores	Mexico	78

[1] A hectare equals 2.47 acres.

MEXICAN NATIONAL PARKS—*Continued*

Name	Date Established	Outstanding Features	Location	Area[1] Hectares
Xicotencatl	Nov. 4, 1937	Historic momuments	Tlaxcala	600
Benito Juarez	Dec. 8, 1937	Hill of the Fortin oak forests	Oaxaca	2,740
Cañon del Rio Blanco	Feb. 22, 1938	Forests; scenic panoramas	Veracruz	55,000
El Chico National Forest	Mar. 10, 1938	Old temperate-zone forest	Hidalgo	1,835
Desierto de Los Leones	Purchased some time after 1876	Preserves the 14 springs that supply drinking water to Mexico City	Federal District	1,900
El Sabinal	Aug. 3, 1938		Nuevo Leon	9
Lagunas de Zempoala	Sept. 30, 1936	Handsome lakes on ridge between Valley of Mexico and Valley of Cuernavaca	Mexico and Morelos	23,500
Pico de Orizaba	Dec. 16, 1936	Highest peak in Mexico	Pueblo and Veracruz	19,750
El Tepeyac	Jan. 27, 1937	Mountain area with scenic views of Mexico City and lagoon of Texoco	Federal District	1,500
El Tepozteco	Jan. 13, 1937	Archeological and geological area; forests	Morelos	24,000
Barranca de Chapultepec	Feb. 20, 1937	Head of Balsas River; tropical forest	Morelos	2,000
Zoquiapan y Anexas	Feb. 19, 1937	Furnishes panoramic view of Ixta-Popo	Mexico	2,000
Los Remedios	Mar. 28, 1938	Seat of first colonial government of New Spain	Mexico	358
El Historico Coyoacan	Sept. 7, 1938	Town of Coyoacan, seat of first colonial government of New Spain	Federal District	584
Lomas de Padierna	Mar. 28, 1938	Site of Battle of August 20, 1847, Mexican War	Federal District	670
Cerro de la Estrella	July 27, 1938	Hill where Aztecs celebrated the Renovation of the Sacred Fire	Federal District	1,100
La Malinche or Matlelcueyatl	Sept. 21, 1938	Mountain of La Malinche, noted for its beauty, the vegetation and the legends that have grown up about it	Tlaxcala	39,426

[1] A hectare equals 2.47 acres.

MEXICAN NATIONAL PARKS—*Continued*

Name	Date Established	Outstanding Features	Location	Area[1] Hectares
Barranca de Cupatitzio...	Sept. 29, 1938	Majestic cascades; fruit and ornamental trees	Michoacan	527
Insurgente Jose Maria Morelos.....	Jan. 18, 1939	Springs which form Salto River	Michoacan	1,813
Sacromonte.....	Apr. 12, 1939	Historic peak and scenic view	Mexico	5
Cumbres de Majalca.....	Mar. 29, 1939	Canyons; geological formations; varied flora	Chihuahua	4,773
Cumbres de Monterrey...	Oct. 4, 1939	Picturesque scenery; varied flora and fauna	Nuevo Leon	2,465
Balneario los Novillos.....	Apr. 26, 1940	Natural beauty spot in Villa Acuna; oak and walnut forests	Coahuila	54
Lago de Camecuaro.....	June 18, 1940	A tiny lake of surprising beauty	Michoacan	14
Pico de Tancitaro.....	July 2, 1940	Majestic mountain area	Michoacan	29,316
Bosencheve.....	Aug. 1, 1940	Beautiful forests	Michoacan and Mexico	21,500

Total, 42 areas of 549,458 hectares or about 1,357,187 acres.

[1] A hectare equals 2.47 acres.

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